



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of: :  
: Abel C. Dasylva et al. : Group Art Unit: 2633  
: :  
Appln. No.: 09/749,946 :  
: Examiner: Agustin Bello  
Filed: December 29, 2000 :  
: :  
For: TECHNIQUE FOR INTERCHANGING :  
WAVELENGTHS IN A MULTI- :  
WAVELENGTH SYSTEM :

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION UNDER 37 C.F.R. § 1.131**

Sir:

I, Abel C. Dasylva, hereby declare that I am a co-applicant in the above-identified patent application and that I am also a co-inventor of the invention that is described and claimed in the above-identified patent application. I also hereby declare that prior to July 31, 2000, my co-inventors and I conceived of the invention that is described and claimed in the above-identified patent application as evidenced by the following:

1. Prior to July 31, 2000, my co-inventors and I conceived of the invention in Canada. At the time of the invention, I owed a duty of assignment of the invention to Nortel Networks Limited (hereinafter "Nortel").

2. Shortly after my co-inventors and I conceived of the invention, my co-inventors and I submitted a description of the invention to the appropriate Nortel patent review committee for purposes of obtaining approval to file a patent application for the invention. A date redacted copy of the description of the invention (i.e., our invention disclosure) is attached hereto as Exhibit A.

3. To the best of my knowledge, the Nortel patent review committee followed its standard procedures in reviewing and subsequently approving of the filing of a patent application based upon our invention disclosure. A date redacted copy of an internal Nortel memo approving the filing of the patent application is attached hereto as Exhibit B.

4. On August 2, 2000, our invention disclosure was forwarded to one of Nortel's outside patent attorneys for preparation of a patent application. A copy of a transmittal letter authorizing preparation of a patent application is attached hereto as Exhibit C.

5. Between August 2, 2000, and December 7, 2000, my co-inventors and I had discussions regarding our invention disclosure with the outside patent attorneys, and provided additional supporting materials to the outside patent attorneys, all intended to assist the outside patent attorneys in preparing a patent application for the invention.

6. On December 7, 2000, I was forwarded a draft of the patent application. A copy of the transmittal letter sending the draft is attached hereto as Exhibit D.

7. On December 27, 2000, I was forwarded a final draft of the patent application. A copy of the transmittal email sending the final draft is attached hereto as Exhibit E.

8. On December 28, 2000, my co-inventors and I approved of the filing of the final draft of the patent application. A copy of the transmittal email sending our approval is attached hereto as Exhibit F.

9. On December 29, 2000, the above-identified patent application was filed. A copy of the filing receipt for the application is attached hereto as Exhibit G.

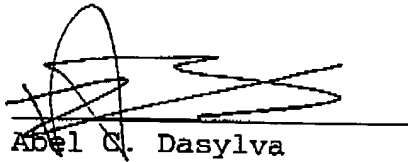
10. On January 30, 2001, I executed the above-identified patent application. A copy of my signed declaration is attached hereto as Exhibit H.

I further hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may

Patent Application  
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Client Reference No.: 12946ROUS01U

jeopardize the validity of the application or any patent issued  
thereon.

DECLARANT:

  
Abel C. DasylvaDate: Sept. 13 2005.



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT A**

**Nortel Networks Confidential & Privileged Information**

**Invention Disclosure Submission Reply**

<b>Disc No:</b>	12946RO	<b>Received Date:</b>	[REDACTED]
<b>Disclosure Title:</b>	Scalable wavelength-interchangers based on frequency comb-shifters		

**----- Inventors -----**

Global ID	Name	Work Info	Home Info
053383 8	HR Name: DASYLVA, ABEL C Known As: ABEL	Location: 21 RICHARDSON SIDE ROAD Dept: 0V13 Phone: 3935034 Ext Phone: 613-763-5034 Fax: 613-763-5692 Ext Fax: 613-763-5692 MailStop: 117D1F04 Citizenship:	Address: 1-70 BOLTON OTTAWA, ON CANADA K1H5A5 Phone: (613)7635034
156217 9	HR Name: MONTUNO, DELFIN Y Known As: DELFIN	Location: 21 RICHARDSON SIDE ROAD Dept: 0V12 Phone: 3933116 Ext Phone: (613) 763-3116 Fax: (ESN)389-1140 Ext Fax: (613) 768-1140 MailStop: 117D1D06 Citizenship: CANADA	Address: 122 KNUDSON DRIVE KANATA, ON CANADA K2K2L8 Phone: (613)5925295

**----- Attachments -----**

**<End of Attachments>**

<b>Were there additional inventors involved:</b>	yes	<b>Was there contractor involvement:</b>	no
<b>Name of Supervisor or Divisional Head:</b>		<b>Name of VP:</b>	
GUO-QIANG WANG		KENT FELSKE	
<b>LOB:</b>	SP&C	<b>Business Unit:</b>	Core Networks
<b>Conception Date:</b>			
<b>Has this invention been discussed with others? If so, please complete:</b>			
<b>Inside Nortel - Whom?</b>	DOMINIC GOODWILL, STAN XAVIER	<b>Outside Nortel - Whom?</b>	
<b>Inside Nortel - When?</b>	[REDACTED]	<b>Outside Nortel - When?</b>	
<b>NDA:</b>	yes		

# Nortel Networks Confidential & Privileged Information

Are you aware of any imminent future disclosures? Please provide dates and details:	
Keywords for Searching:	Products that will use this invention:
	All-optical cross-connects with wavelength-interchanging capabilities
Does this invention arise from any arrangement involving an external organization?	
Is this invention relevant to a Standards Activity?	Internal Funding Project #s:
no	8127

## Technical Information

### Brief Description of the Invention:

We describe a new technique to design wavelength-interchanging OXCs, that use a number of wave-mixing converters of the order of the logarithm of the number of wavelengths. These new OXCs minimize the required number of wavelength-converters by the use of frequency comb-shifters.

### Problem Solved by the Invention:

-Design of wavelength-interchanging OXCs with a minimum number of wave-mixing devices, i.e. a number of the order of the logarithm of the number of wavelengths.

### Solutions that have been tried and why they didn't work:

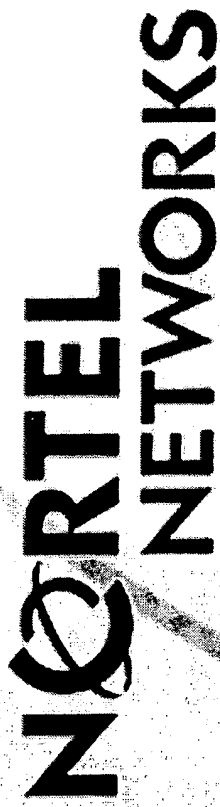
-Dedicated wavelength-converters-Use of wavelength-space transformation equivalent to Marcus time-space transformation  
Problem: The number of wavelength converters is of the order of the number of wavelengths.

### Specific elements or steps that solved the problem and how they do it:

-Design of switch elements sharing state changers based on frequency comb-shifters-Design of the banyan butterfly inter-connection pattern using frequency comb-shifters

### Commercial value of the invention to Nortel and Nortel's major competitors:

Performance advantages:-expected quality of transmissions better than other solutions  
More economical switch fabrics from the point of view:-The number of wave-mixing devices-Power consumption-Overall costs



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# **New Designs for OXCs with Wavelength Interchanging Capabilities**

Abel Dasyva and Delfin Montuno  
MTTP

# Overview

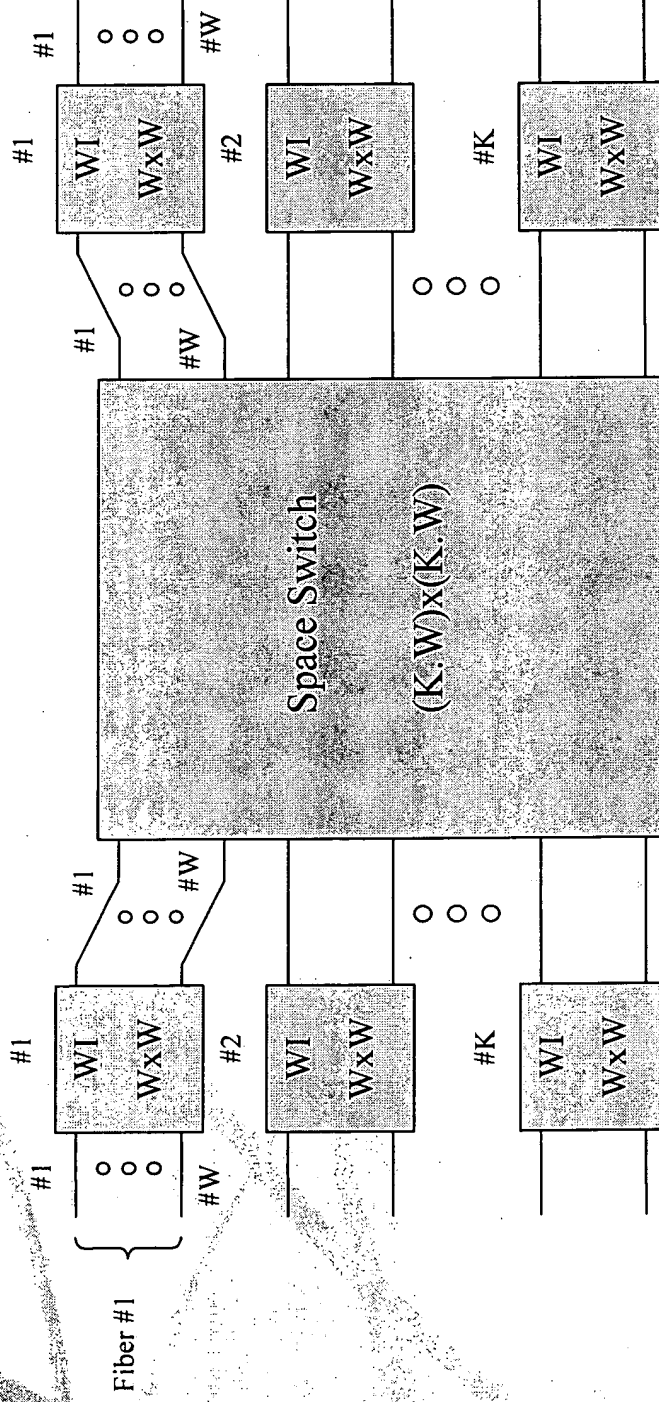
- Importance of wavelength-interchanging OXC's (WIXC's)
- Previous designs for WIXC's
- Problems associated with previous methods
- New design philosophy for WIXC's
- Banyan switch architectures
- Butterfly inter-stage connection pattern using wave-mixers
- Monotonic wavelength-conversion
- Perfect shuffle inter-stage connection pattern based on PFM
- HW requirements of banyan wavelength-inter-changers designed with the new method
- Future work

# Role of WIXCs

- Wavelength-compliance at network boundaries
- Bandwidth provisioning
  - To reduce channel blocking
  - To ease provisioning (simpler Qos routing)
- Contention resolution
  - Deflection routing in optical packet switching networks

# Previous Designs for WIXCs 1/3

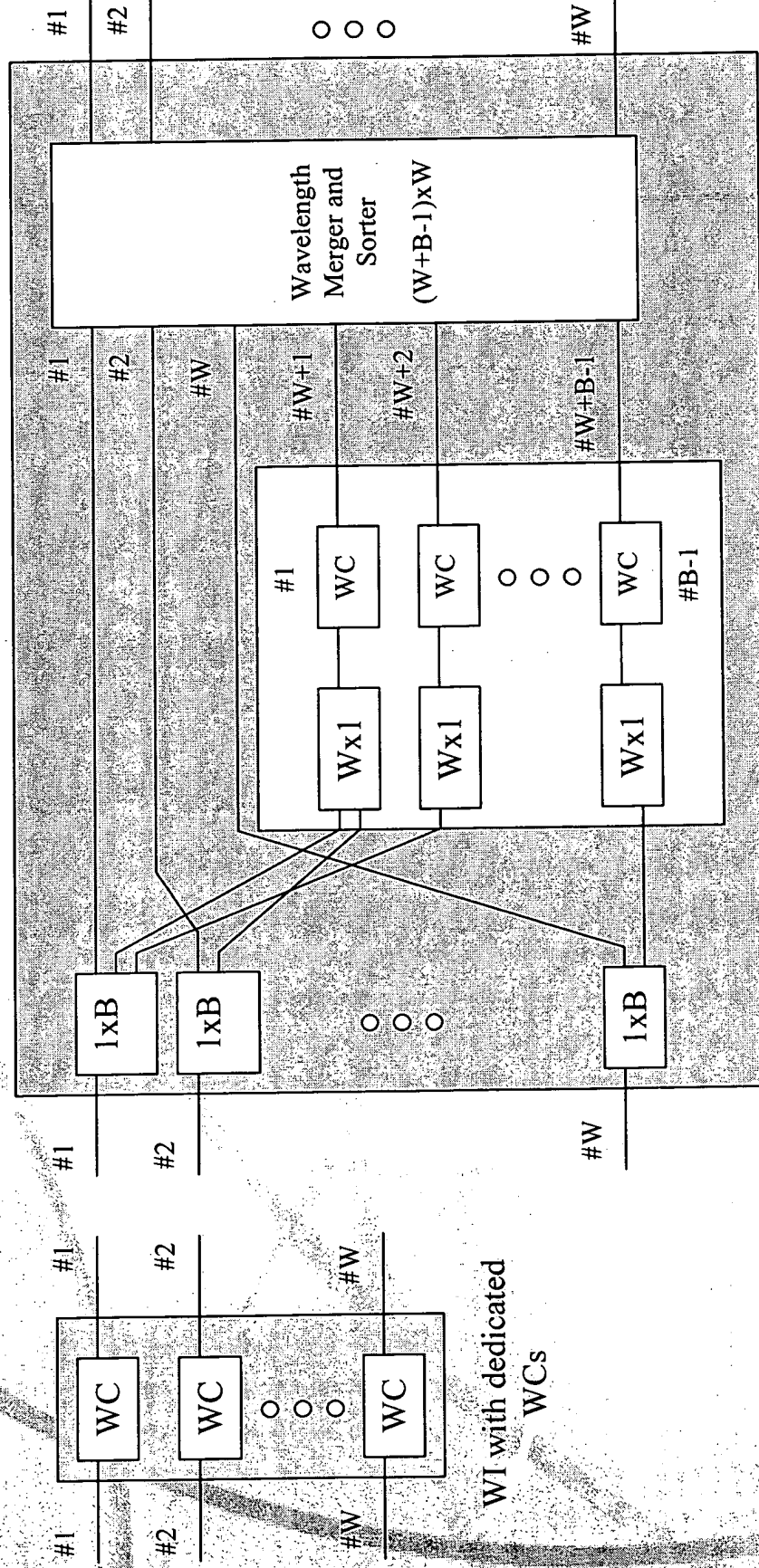
- Ingress/egress wavelength-interchange



WI: Wavelength-interchanger

# Previous Designs for WIXCs 2/3

- Some WI designs

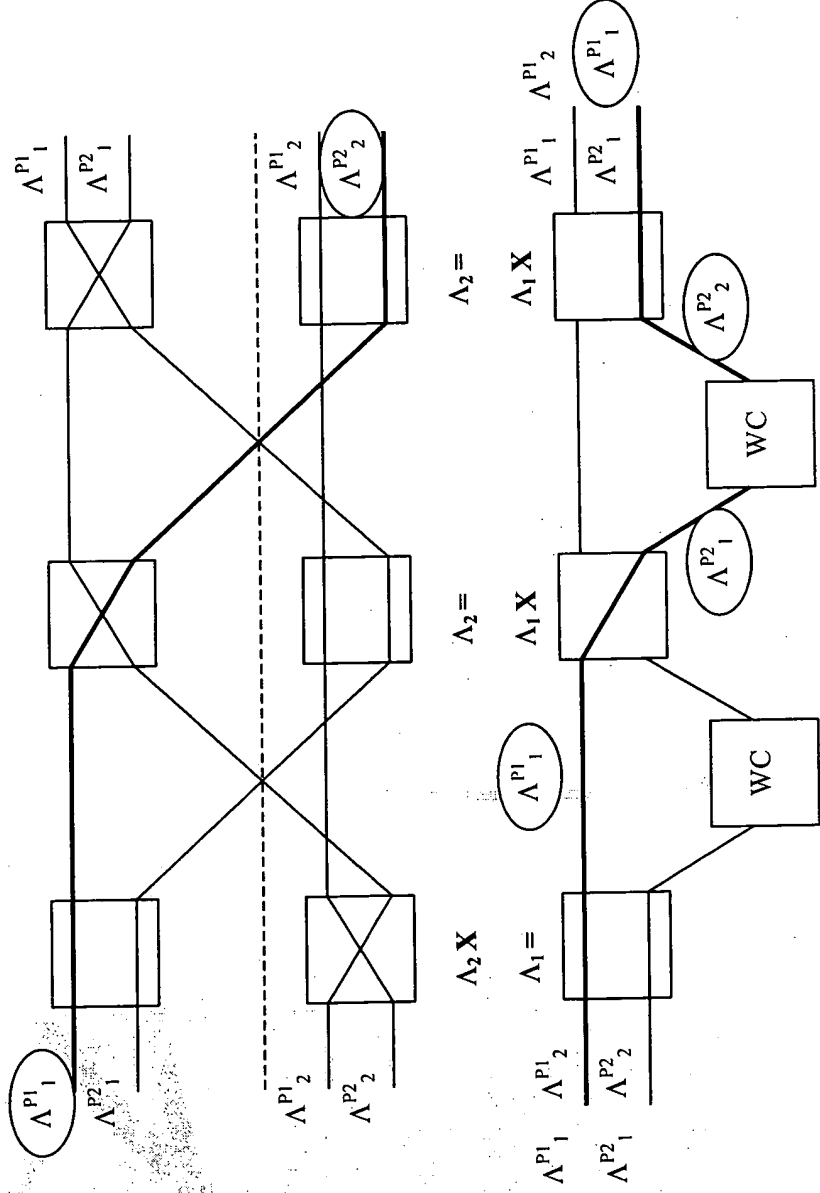


WC: Wavelength-converter



# Previous Designs for WIXCs 3/3

- Use of wavelength-space transformations
- At each stage, switching occurs both in the space and in the wavelength domain
- The resulting number of needed converters is high



# Problems associated with Previous Solutions

- No systematic method to build wavelength inter-connection networks with arbitrary HW requirements or blocking performance
- Poor use of the properties of wave-mixing devices
- Expensive HW requirements for wavelength conversion devices (the design for a rearrangeable Benes type WXC still uses  $W/2$  WM devices per interface)

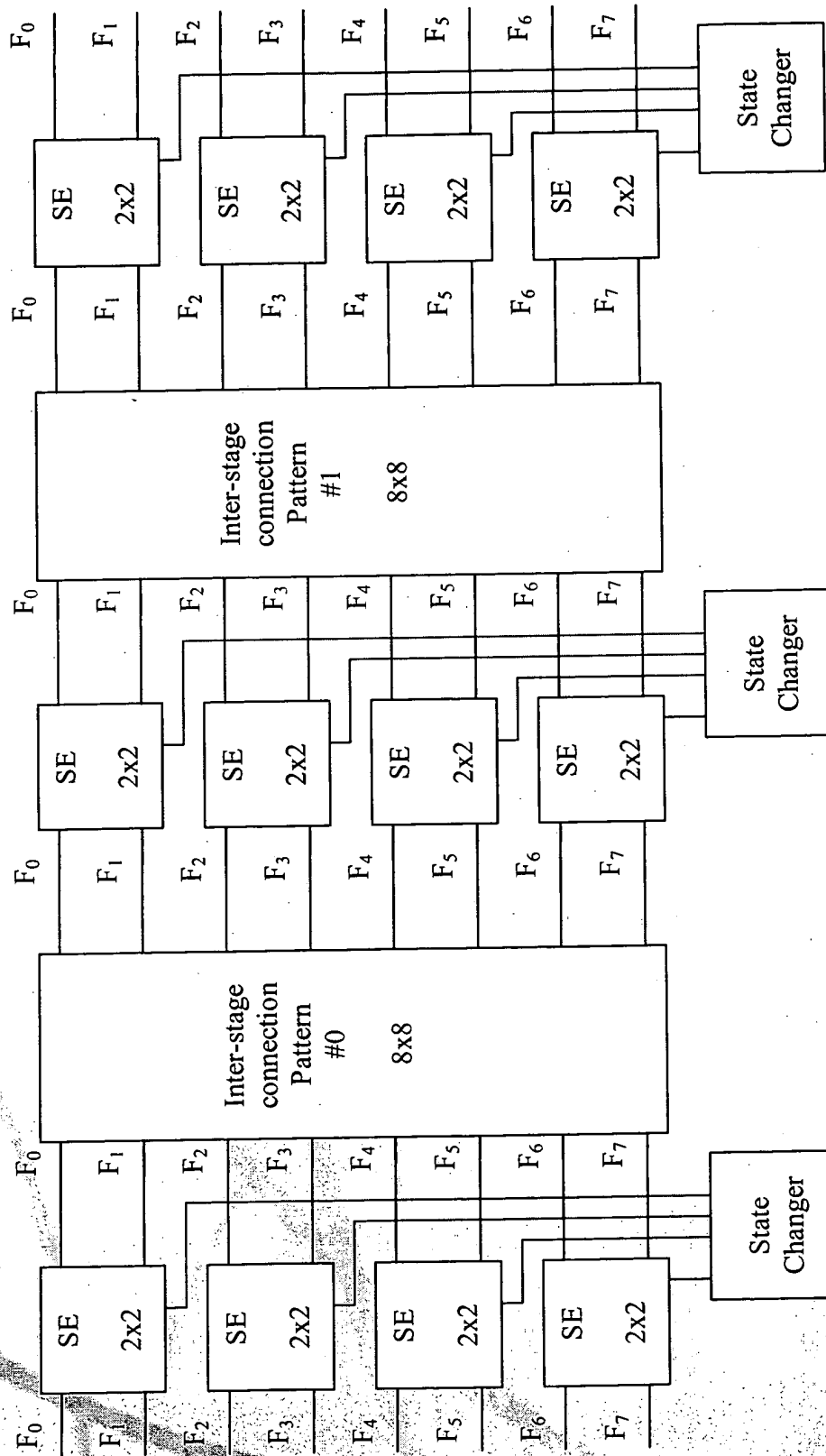
# New Design Philosophy 1/4

- Clear separation of the wavelength-switching domain from the other domains (space and time)
- Wavelength-space-wavelength transformation
- Use of transparent parametric wavelength-conversion
- Separate the design of switch elements (SEs) from the design of specific Inter-Stage Connection (ISC) patterns
- Design of ISC patterns through a new method based on monotonic

WC

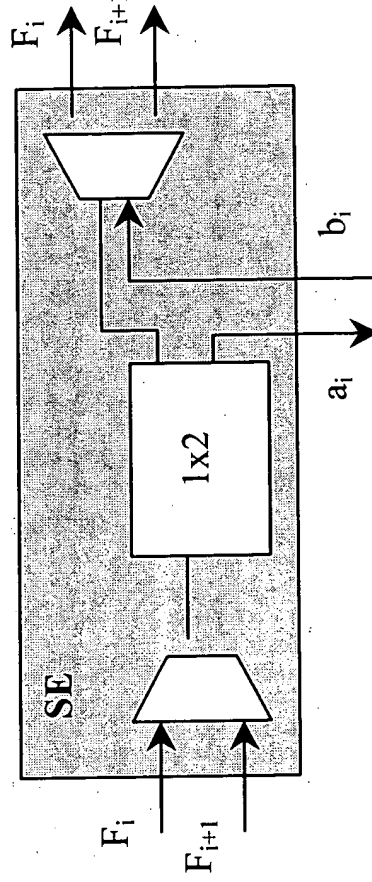
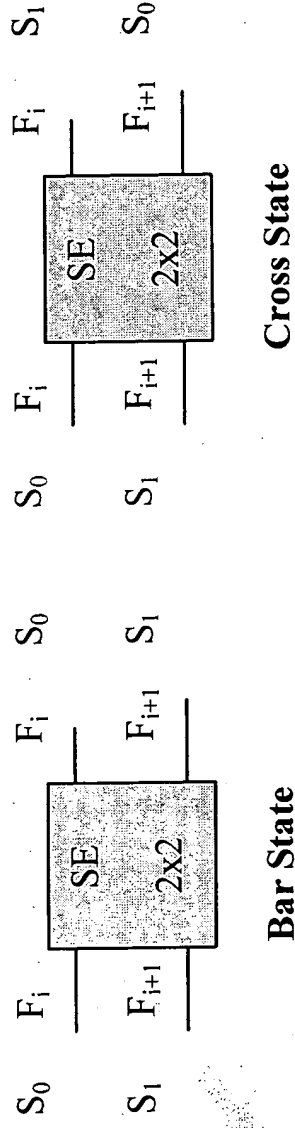
# New Design Philosophy 2/4

- Example in the wavelength domain



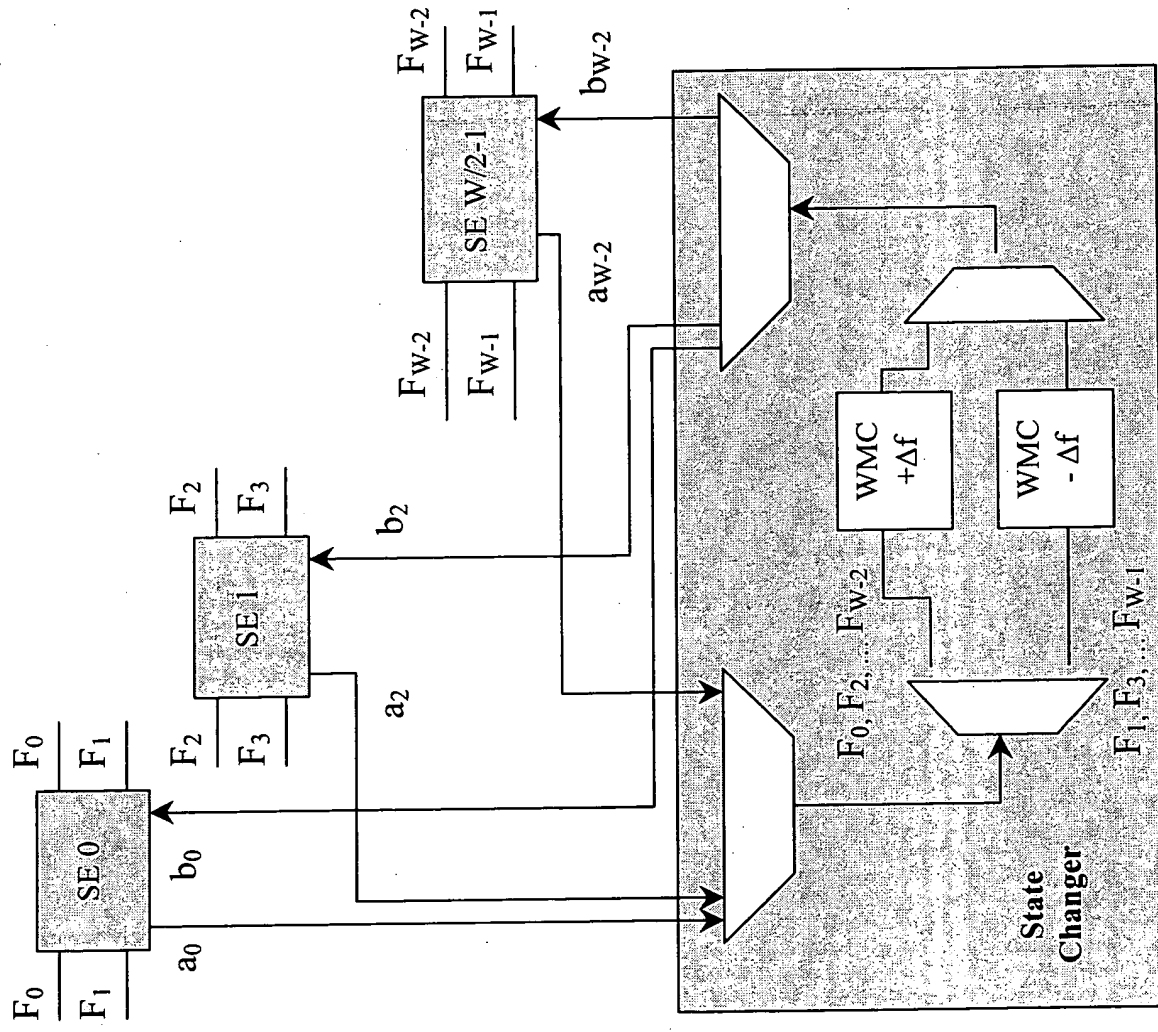
# New Design Philosophy 3/4

- Design of 2x2 SEs



# New Design Philosophy 4/4

- Design of 2x2 SEs



# Banyan Switch Architectures 1/2

Basic ISC patterns described in terms of bit patterns:

$$\sigma_h(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_{h-1} \dots a_0 a_h, 0 \leq h \leq n-1$$

$$\sigma_h^{-1}(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_0 a_h \dots a_1, 0 \leq h \leq n-1$$

$$\beta_h(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_0 a_{h-1} \dots a_1 a_h, 0 \leq h \leq n-1$$

$$j(a_{n-1} \dots a_0) = a_{n-1} \dots a_0, 0 \leq h \leq n-1$$

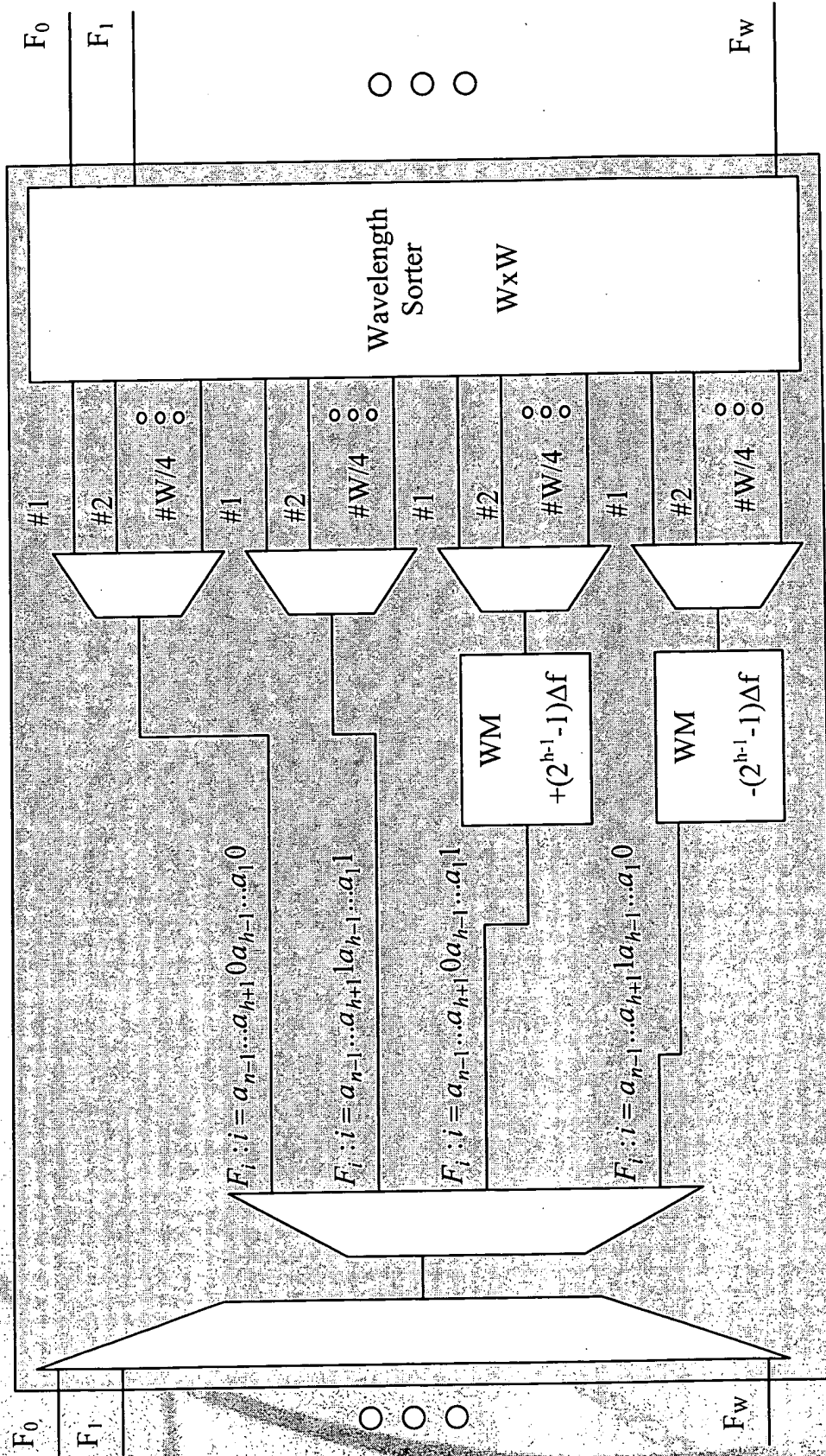
# Banyan Switch Architectures 2/2

Networks:

	$P(0)$	$P(h), 0 < h < n$	$P(n)$
Omega	$\sigma_{n-1}$	$\sigma_{n-1}$	J
Omega <sup>-1</sup>	J	$\sigma_{n-1}^{-1}$	$\sigma_{n-1}^{-1}$
SW-banyan	J	$\beta_h$	J
SW-banyan	J	$\beta_{n-h}$	J
n-cube	$\sigma_{n-1}$	$\beta_{n-h}$	J
n-cube <sup>-1</sup>	J	$\beta_h$	$\sigma_{n-1}^{-1}$
Baseline	J	$\sigma_h^{-1}$	J



# Butterfly ISC Pattern based on Wave-Mixing

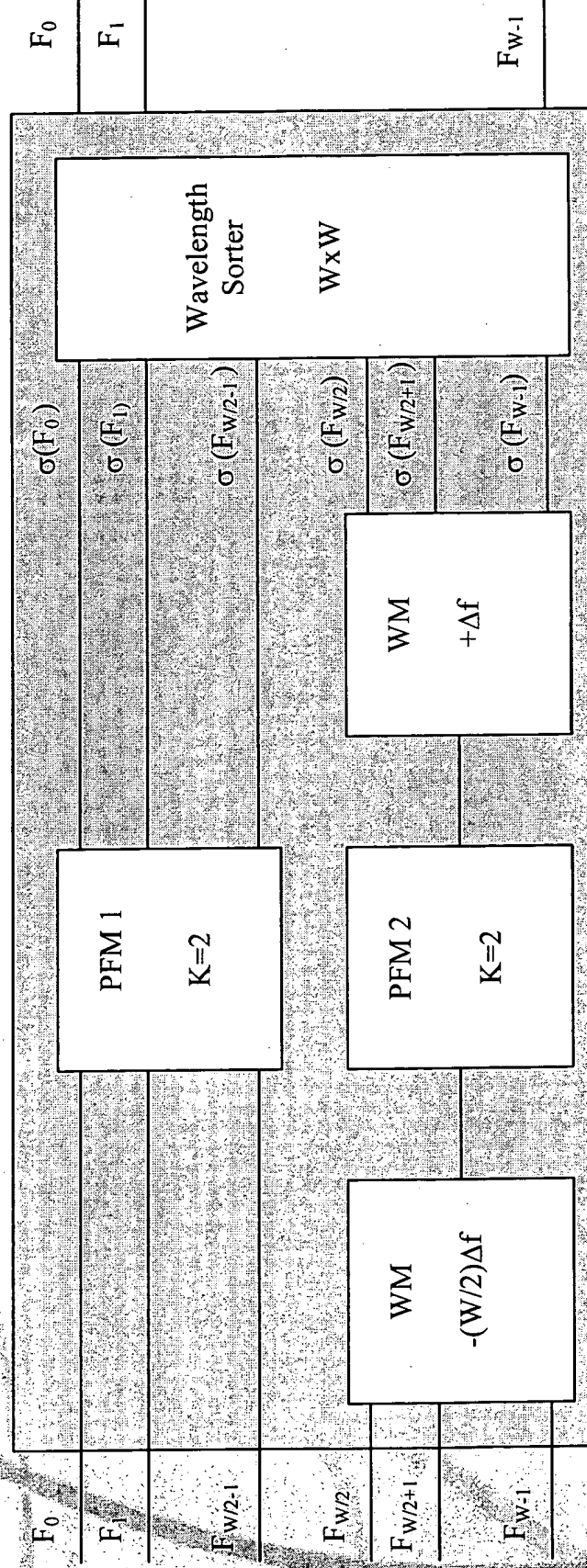


# Monotonic WC

- Wavelength-mapping operation that preserves or simply inverts the ordering relationships of wavelengths
- Devices implementing monotonic WC may be implemented with a number of wave-mixing components of the order of the logarithm of the number of wavelengths ( $O(\log(W))$ )
- Pseudo frequency multiplication
  - Mapping of  $F_i$  to  $F_{k,i}$ , for any  $i$
  - PFM is a specific example of monotonic WC

# Perfect Shuffle ISC Pattern based on PFM

- Perfect frequency shuffler using  $O(\log(W))$  wave mixing devices



# HW Requirements of Banyan Ws Designed with the New Approach

- New method

	Number of WM Devices used
Omega	$O(\log(W)^2)$
Omega <sup>-1</sup>	$O(\log(W)^2)$
SW-banyan	$O(\log(W))$
SW-banyan	$O(\log(W))$
n-cube	$O(\log(W))$
n-cube <sup>-1</sup>	$O(\log(W))$
Baseline	$O(\log(W)^2)$

- Previous approaches usually require a number of WMs of the order of  $W$

# Future Work

- Design of WIXCs with arbitrary properties in terms of the following characteristics
  - Blocking properties: rearrangeable, wide-sense non-blocking, strictly non-blocking
  - Inter-stage connection density: full/partial connection
- Impact on the transmission quality (noise, cross-talk, dispersion, ...etc), and performance requirements for WM devices to be used in the new approach
- Multicast support
- Switches with several multiplexing levels (time, wavelength and space)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT B**

**INVENTION DISCLOSURE REVIEW SUMMARY/DISPOSITION**

Initial Review Date: \_\_\_\_\_

Disclosure No.: <u>1294620</u>	Product Group: _____
Title of Disclosure: <u>Scalable Wavelength - Interchanges</u>	Business Unit: <u>EBTS</u>
Standards Related: <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes	<input checked="" type="checkbox"/> Nortel Inventors only
Applicable Standards: _____	<input type="checkbox"/> Nortel and Contractor Inventors
Technology Areas: <u>Optical Switch Fabric</u>	Product/Project: _____
Strategic Focus Area: <u>Optical Networks</u>	<u>MTTP</u>

**REVIEW SUMMARY**

**GIST OF THE INVENTION**

Summarize within a few lines what the major thrust of the invention is, e.g. a software program to be added to voice networks, such as Meridian, which will allow instantaneous translations from French to English.

new architecture for interstage connection patterns

**BENEFIT FROM THE INVENTION**

Summarize within a few lines how the invention will benefit its target benefactor, e.g. subscribers will be able to retrieve multi-lingual messages instantaneously without having to employ additional time consuming translation processes which may not be readily available.

fewer active components needed

**Ranking/Scoring Data**

a. Technological Thrust: 3 (0-3)

b. Inventive Value: 3 (0-3)

c. Commercial Value: 3 (0-3)

OVERALL SCORE: 9

**FINAL DISPOSITION**

Final Disposition Date: \_\_\_\_\_

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> File Patent Application -- Target Filing Date: _____ | <input type="checkbox"/> Close without filing                  |
| <input type="checkbox"/> Combine with/include in Disclosure No.: _____                   | <input type="checkbox"/> Reconsider/Table (see comments below) |
| <input type="checkbox"/> Other (e.g., publish, Tech. Licensing, etc.)                    |  |

Comments: \_\_\_\_\_

Critical Filing Date (If Applicable): \_\_\_\_\_

Foreign Filing Potential: ☐ No  
☒ Yes

(circle) Tier 1  
(UK, DE, FR, CA)

Tier 2: \_\_\_\_\_  
(Please specify)

(Revised) \_\_\_\_\_

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT C**



Kim LaRocca  
Outsource Administrator  
Intellectual Property Law Group  
600 Technology Park Drive, MS E65-60-403  
Billerica, Massachusetts 01821-5501  
Tel 978-288-6754 Fax 978-288-6543  
[www.nortelnetworks.com](http://www.nortelnetworks.com)



*How the world shares ideas.*

**NORTEL NETWORKS CONFIDENTIAL &  
PRIVILEGED COMMUNICATION**

August 2, 2000

CONFIDENTIAL

VIA FACSIMILE 202 778-2201, ORIGINAL NOT SENT

Thomas E. Anderson, Esq.  
Hunton & Williams  
1900 K Street, N.W.  
Washington, DC 20006-1109

Re: **Invention Docket No.: 12946RO**  
**Title: Scalable Wavelength-Interchangers Based on Frequency Comb-Shifters**  
**Required Filing Date: November 2, 2000**

Dear Attorney Anderson:

Nortel Networks would like to retain your firm to prepare and file in the United States Patent and Trademark Office (USPTO) a patent application directed to the invention disclosed in the enclosed invention disclosure by the above-referenced filing date. The application should be prepared according to Nortel Networks guidelines, and in accordance with the predetermined fee we have agreed with your firm; for the total fee of about [REDACTED] exclusive of drawing(s) and USPTO filing fees. If you are unable to perform the requested work, please advise me immediately.

In addition to the invention disclosure, an invention disclosure Review Summary document is enclosed for your consideration. We request that you contact the primary inventor, Abel Dasylyva, at (613) 763-5034 within two weeks of receiving this letter. Please ensure that the inventor(s) are advised of their responsibilities regarding their duty of candor to the USPTO, as well as any other relevant rules and/or laws including the best mode requirement.

We also ask that you quickly review the contents of this letter and its enclosures to ascertain whether or not any bar dates appear to be imminent. If so, we ask that you develop a plan of action to protect Nortel Networks' intellectual property rights in the invention disclosure.

Questions pertaining to substantive issues associated with the application should be addressed with the responsible attorney at (978) 288-6997, while administrative issues associated with the application should be addressed with me. Please be sure that all communications associated with the application, including billing statements and the application itself bear the above-referenced disclosure number.

Please send a substantially complete and final draft of the application to me along with a completed Nortel Networks Outsource's Patent Application Checklist at least 10 days prior to the above-referenced filing date to provide Nortel Networks' Intellectual Property Law Group sufficient opportunity to review the application prior to filing. You should seek to obtain the signatures on the formal papers from all inventors directly.

August 2, 2000  
Thomas E. Anderson, Esq  
Page 2

Upon filing the application with the USPTO, immediately fax a copy of the application transmittal letter and Declaration to me, so that we have a record that the application has been filed. Thereafter, please send me a hardcopy of the application as filed along with an electronic copy in Microsoft Word 6.0 readable format on a 3 1/2" floppy disk.

Please confirm receipt of this letter via facsimile. Should you have any questions, please call me at 978-288-6754.

Very truly yours,



Kim LaRocca

Enclosures:

cc: Invention Disclosure No.: 12946RO  
Review Summary

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT D**

**HUNTON &  
WILLIAMS**

1900 K STREET, N.W.  
WASHINGTON, D.C. 20006-1109

TEL 202 • 955 • 1500  
FAX 202 • 778 • 2201

THOMAS E. ANDERSON  
DIRECT DIAL: 202 • 955 • 1808  
EMAIL: anderson@hunton.com

FILE NO: 57983.000018

December 7, 2000

**VIA FACSIMILE**

Mr. Abel C. Dasyva  
Nortel Networks  
21 Richardson Side Road  
M/S 117D1F04  
Kanata ON K2K 2C1  
Canada

Re: New U.S. Patent Application  
Title: "SCALABLE WAVELENGTH-INTERCHANGERS BASED  
ON FREQUENCY COMB-SIFTERS"  
Your Ref.: 12946RO  
Our Ref.: 57983-000018

Dear Abel:

Enclosed please find a copy of a draft of the above-identified patent application for your review. The enclosed copy is exactly the same as the one that I emailed to you earlier.

Please review this application to determine if it accurately and adequately describes your invention, noting on the enclosed draft any comments or suggestions you may have.

After you have completed your review, please return the draft to me. The patent application will then be placed in a condition for filing in the U.S. Patent and Trademark Office (USPTO), and a final version of the patent application will be sent to you for execution.

Also, pursuant to USPTO rules, a statement must be submitted disclosing to the USPTO all presently known information believed material to the examination of the above-identified patent application. Information is considered material if there is a substantial likelihood that the information would be considered important in deciding patentability. Accordingly, please send for my review all presently known patents, publications, or other published materials relating to the subject invention. Please note that you are not required to do any research to locate information that is not already known by you.



Mr. Abel Dasylva  
December 8, 2000  
Page 2

Accurate and complete disclosure of material information facilitates the examination phase of the patent application, and most importantly, strengthens the presumption of validity accorded any patent issuing thereon.

If you have any questions concerning the review of the patent application or the submission of material information, please do not hesitate to contact me directly at the above-listed number.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'TEA', with a long, sweeping horizontal line extending to the right.

Thomas E. Anderson

TEA/vll  
Enclosure

cc: Holmes Anderson (via fax)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT E**

**Anderson, Thomas**

---

**From:** Anderson, Thomas  
**Sent:** Wednesday, December 27, 2000 9:45 PM  
**To:** Abel C. Dasyiva (E-mail)  
**Subject:** Your: 12946RO / Our: 57983-000018



3nnr011.doc

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT F**



**Anderson, Thomas**

---

**From:** Abel Dasyiva [abel@nortelnetworks.com]  
**Sent:** Thursday, December 28, 2000 4:06 PM  
**To:** 'Anderson, Thomas'  
**Cc:** Delfin Montuno  
**Subject:** Filing of invention 12946RO

Thomas,

Delfin and I approve of your filing our invention 12946RO.

Thanks,

-Abel

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT G**



## UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS  
UNITED STATES PATENT AND TRADEMARK OFFICE  
WASHINGTON, D.C. 20231  
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
09/749,946	11/29/2000	2633	710	57983.000018	25	16	2

CONFIRMATION NO. 6810

## FILING RECEIPT



\*OC000000005756560\*

Thomas E. Anderson  
Hunton & Williams  
1900 K Street, N.W.  
Washington, DC 20006-1109

Date Mailed: 02/12/2001

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the PTO processes the reply to the Notice, the PTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).

## Applicant(s)

Abel C. Dasylya, Residence Not Provided;  
Delfin Y. Montuno, Residence Not Provided;  
Guo-Qiang Wang, Residence Not Provided;

## Continuing Data as Claimed by Applicant

## Foreign Applications

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

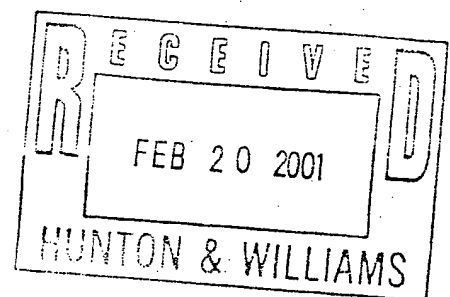
Early Publication Request: No

## Title

Technique for interchanging wavelengths in a multi-wavelength system

## Preliminary Class

359



REVIEWED  
SW

---

Data entry by : GURMU, MULUEMEBET

Team : OIPE

Date: 02/12/2001



**LICENSE FOR FOREIGN FILING UNDER**  
**Title 35, United States Code, Section 184**  
**Title 37, Code of Federal Regulations, 5.11 & 5.15**

**GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 36 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

**NOT GRANTED**

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15 (b).

**PLEASE NOTE the following information about the Filing Receipt:**

- The articles such as "a," "an" and "the" are not included as the first words in the title of an application. They are considered to be unnecessary to the understanding of the title.
- The words "new," "improved," "improvements in" or "relating to" are not included as first words in the title of an application because a patent application, by nature, is a new idea or improvement.
- The title may be truncated if it consists of more than 600 characters (letters and spaces combined).
- The docket number allows a maximum of 25 characters.
- If your application was submitted under 37 CFR 1.10, your filing date should be the "date in" found on the Express Mail label. If there is a discrepancy, you should submit a request for a corrected Filing Receipt along with a copy of the Express Mail label showing the "date in."
- The title is recorded in sentence case.

Any corrections that may need to be done to your Filing Receipt should be directed to:

Assistant Commissioner for Patents  
Office of Initial Patent Examination  
Customer Service Center  
Washington, DC 20231

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT H**

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: "TECHNIQUE FOR INTERCHANGING WAVELENGTHS IN A MULTI-WAVELENGTH SYSTEM", the specification of which:

(X only one)      (a) \_\_\_\_\_ is attached hereto.  
                              (b)   X   was filed as U.S. Patent Application No. 09/749,946 on December 29, 2000, and was amended on \_\_\_\_\_, 20\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby acknowledge the duty to disclose to the Office all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56, including, for a continuation-in-part application, material information which became available between the filing date of the prior application and the national or international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate, under 35 U.S.C. § 365(a) of any international application(s) designating at least one country other than the United States, or under 35 U.S.C. § 365(b) of any foreign application(s) for patent or inventor's certificate or any international application(s) designating at least one country other than the United States, listed below, and have also identified below any foreign application(s) for patent or inventor's certificate or any international application(s) having a filing date before that of any application on which priority is claimed:

Application No.	Country	Filing Date (MM/DD/YY)	Priority Claimed?
_____	_____	_____	_____



I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

Application No.	Filing Date (MM/DD/YY)
_____	_____
_____	_____

I hereby claim the benefit under 35 U.S.C. § 120 of any United States non-provisional application(s) listed below:

Application No.	Filing Date (MM/DD/YY)	Status (Patented, Pending, Abandoned)
_____	_____	_____
_____	_____	_____

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

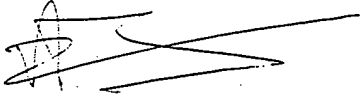
I hereby appoint: Thomas E. Anderson, Registration No. 37,063; Stanislaus Aksman, Registration No. 28,562; Jennifer A. Albert, Registration No. 32,012; David E. Baker, Registration No. 42,285; Scott D. Balderston, Registration No. 35,436; Carl L. Benson, Registration No. 38,378; Bradford Blaise, Registration No. P47,429; Thomas M. Blasey, Registration No. 33, 475; Brian M. Buroker, Registration No. 39,125; Christopher C. Campbell, Registration No. 37,291; Robin C. Clark, Registration No. 40,956; Christopher J. Cuneo, Registration No. 42,450; Patrick A. Doody, Registration No. 35,022; Kevin T. Duncan, Registration No. 41,495; David D'Zurilla, Registration No. 36,776; Ozzie Farres, Registration No. 43,606; Nancy Flint, Registration No., 46,704; Christopher J. Forstner, Registration No. 46,049; James G. Gatto, Registration No. 32,694; George Georgellis, Registration No. 43,632; Paramita Ghosh, Registration No., 42,806; Paul D. Golian,

Registration No. 42,951; Charles F. Hollis, Registration No. 40,650; David M. Huntley, Registration No. 40,309; Nancy J. Jensen, Registration No. 45,913; Herbert V. Kerner, Registration No. 42,721; Steven P. Klocinski, Registration No. 39,251; Jonathan D. Link, Registration No. 41,548; J. Michael Martinez, Registration No. 31,178; David H. Milligan, Registration No. 42,893; James R. Miner, Registration No. 40,444; Devin S. Morgan, Registration No. 45,562; Kerry H. Owens, Registration No. 37,412; Andrew J. Ririe, Registration No. 45,597; Robert M. Schulman, Registration No. 31,196; Thomas J. Scott, Jr., Registration No. 27,836; 647 Stuart I. Smith, Registration No. 42,159; Yisun Song, Registration No. 44,487; Raphael A. Valencia, Registration No. 43,216; Rene' Vazquez, Registration No. 38,647; and Scott F. Yarnell, Registration No. 45,245, all of the firm **Hunton & Williams**, 1900 K Street, NW, Washington, DC 20006, as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application, and any provisionals, continuations, continuations-in-part, divisionals, appeals, reissues, substitutions, re-examinations, and extensions thereof, and to transact all business in the United States Patent and Trademark Office connected therewith, to appoint any individuals under an associate power of attorney, and to file and prosecute any international patent application based thereon before any international authorities.

Please address all correspondence and direct all telephone calls to:

Thomas E. Anderson  
Hunton & Williams  
1900 K Street, N.W.  
Washington, D.C. 20006-1109  
telephone (202) 955-1500  
facsimile (202) 778-2201

**NAMED INVENTOR(S):**

1	<b>Full Name</b> Abel C. Dasylyva	<b>Inventor's Signature</b> 	<b>Date</b> 01/30/2001
	<b>Residence (city, state, country)</b> 1-70 Bolton Ottawa, ON Canada K1H 5A5		<b>Citizenship</b> Ivory Coast
	<b>Post Office Address (include zip code).</b> Same as residence		

2	<b>Full Name</b>	<b>Inventor's Signature</b>	<b>Date</b>
	Delfin Y. Montuno	<i>Delfin Y. Montuno</i>	Jan. 31, 2001
	<b>Residence (city, state, country)</b> <b>Citizenship</b>  122 Knudson Drive Kanata, ON Canada K2K 2L8  CANADA		
	<b>Post Office Address (include zip code)</b>  Same as residence		

3	<b>Full Name</b> Guo-Qiang Wang	<b>Inventor's Signature</b> <i>G. Q. Wang</i>	<b>Date</b> <i>Jan 30, 2001</i>
	<b>Residence (city, state, country)</b> 175 Longshire Circle Nepean, ON Canada K2J4L2	<b>Citizenship</b> Canada	
	<b>Post Office Address (include zip code)</b> Same as residence		



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of: :  
: Abel C. Dasyuva et al. : Group Art Unit: 2633  
: :  
Appln. No.: 09/749,946 :  
: Examiner: Agustin Bello  
Filed: December 29, 2000 :  
: :  
For: TECHNIQUE FOR INTERCHANGING :  
WAVELENGTHS IN A MULTI- :  
WAVELENGTH SYSTEM :

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION UNDER 37 C.F.R. § 1.131**

Sir:

I, Delfin Y. Montuno, hereby declare that I am a co-applicant in the above-identified patent application and that I am also a co-inventor of the invention that is described and claimed in the above-identified patent application. I also hereby declare that prior to July 31, 2000, my co-inventors and I conceived of the invention that is described and claimed in the above-identified patent application as evidenced by the following:

1. Prior to July 31, 2000, my co-inventors and I conceived of the invention in Canada. At the time of the invention, I owed a duty of assignment of the invention to Nortel Networks Limited (hereinafter "Nortel").

2. Shortly after my co-inventors and I conceived of the invention, my co-inventors and I submitted a description of the invention to the appropriate Nortel patent review committee for purposes of obtaining approval to file a patent application for the invention. A date redacted copy of the description of the invention (i.e., our invention disclosure) is attached hereto as Exhibit A.

3. To the best of my knowledge, the Nortel patent review committee followed its standard procedures in reviewing and subsequently approving of the filing of a patent application based upon our invention disclosure. A date redacted copy of an internal Nortel memo approving the filing of the patent application is attached hereto as Exhibit B.

4. On August 2, 2000, our invention disclosure was forwarded to one of Nortel's outside patent attorneys for preparation of a patent application. A copy of a transmittal letter authorizing preparation of a patent application is attached hereto as Exhibit C.

5. Between August 2, 2000, and December 7, 2000, my co-inventors and I had discussions regarding our invention disclosure with the outside patent attorneys, and provided additional supporting materials to the outside patent attorneys, all intended to assist the outside patent attorneys in preparing a patent application for the invention.

6. On December 7, 2000, one of my co-inventors was forwarded a draft of the patent application. A copy of the transmittal letter sending the draft is attached hereto as Exhibit D.

7. On December 27, 2000, one of my co-inventors was forwarded a final draft of the patent application. A copy of the transmittal email sending the final draft is attached hereto as Exhibit E.

8. On December 28, 2000, my co-inventors and I approved of the filing of the final draft of the patent application. A copy of the transmittal email sending our approval is attached hereto as Exhibit F.

9. On December 29, 2000, the above-identified patent application was filed. A copy of the filing receipt for the application is attached hereto as Exhibit G.

10. On January 30, 2001, I executed the above-identified patent application. A copy of my signed declaration is attached hereto as Exhibit H.

I further hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

United States Code, and that such willful false statements may  
jeopardize the validity of the application or any patent issued  
thereon.

DECLARANT:

  
Delfin Y. MontunoDate: Sept. 13, 2005

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT A**

**Nortel Networks Confidential & Privileged Information**

## Invention Disclosure Submission Reply

<b>Disc No:</b>	12946RO	<b>Received Date:</b>	
<b>Disclosure Title:</b>	Scalable wavelength-interchangers based on frequency comb-shifters		

### ----- Inventors -----

Global ID	Name	Work Info	Home Info
053383 8	HR Name: DASYLVA, ABEL C Known As: ABEL	Location: 21 RICHARDSON SIDE ROAD Dept: 0V13 Phone: 3935034 Ext Phone: 613-763-5034 Fax: 613-763-5692 Ext Fax: 613-763-5692 MailStop: 117D1F04 Citizenship:	Address: 1-70 BOLTON OTTAWA, ON CANADA K1H5A5 Phone: (613)7635034
156217 9	HR Name: MONTUNO, DELFIN Y Known As: DELFIN	Location: 21 RICHARDSON SIDE ROAD Dept: 0V12 Phone: 3933116 Ext Phone: (613) 763-3116 Fax: (ESN)389-1140 Ext Fax: (613) 768-1140 MailStop: 117D1D06 Citizenship: CANADA	Address: 122 KNUDSON DRIVE KANATA, ON CANADA K2K2L8 Phone: (613)5925295

### ----- Attachments -----

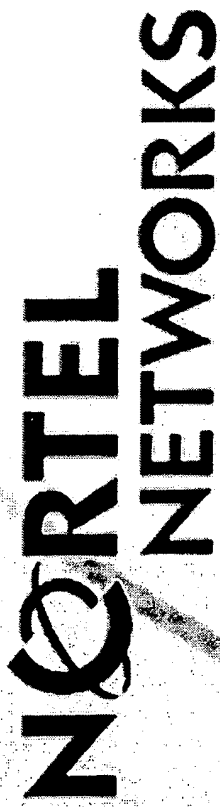
<End of Attachments>

<b>Were there additional inventors involved:</b>	yes	<b>Was there contractor involvement:</b>	no
<b>Name of Supervisor or Divisional Head:</b>		<b>Name of VP:</b>	
GUO-QIANG WANG		KENT FELSKE	
<b>LOB:</b>	SP&C	<b>Business Unit:</b>	Core Networks
<b>Conception Date:</b>			
<b>Has this invention been discussed with others? If so, please complete:</b>			
<b>Inside Nortel - Whom:</b>	DOMINIC GOODWILL, STAN XAVIER	<b>Outside Nortel - Whom:</b>	
<b>Inside Nortel - When:</b>		<b>Outside Nortel - When:</b>	
<b>NDAX:</b> yes			

# Nortel Networks Confidential & Privileged Information

Are you aware of any imminent future disclosures? Please provide dates and details:	
Keywords for Searching:	Products that will use this invention:
	All-optical cross-connects with wavelength-interchanging capabilities
Does this invention arise from any arrangement involving an external organization?	
Is this invention relevant to a Standards Activity?	Internal Funding Projects:
no	8127

<b>Technical Information</b>	
<b>Brief Description of the Invention:</b>	
We describe a new technique to design wavelength-interchanging OXCs, that use a number of wave-mixing converters of the order of the logarithm of the number of wavelengths. These new OXCs minimize the required number of wavelength-converters by the use of frequency comb-shifters.	
<b>Problem Solved by the Invention:</b>	
-Design of wavelength-interchanging OXCs with a minimum number of wave-mixing devices, i.e. a number of the order of the logarithm of the number of wavelengths.	
<b>Solutions that have been tried and why they didn't work:</b>	
-Dedicated wavelength-converters-Use of wavelength-space transformation equivalent to Marcus time-space transformation Problem: The number of wavelength converters is of the order of the number of wavelengths.	
<b>Specific elements or steps that solved the problem and how they do it:</b>	
-Design of switch elements sharing state changers based on frequency comb-shifters-Design of the banyan butterfly inter-connection pattern using frequency comb-shifters	
<b>Commercial value of the invention to Nortel and Nortel's major competitors:</b>	
Performance advantages:-expected quality of transmissions better than other solutions More economical switch fabrics from the point of view:-The number of wave-mixing devices-Power consumption-Overall costs	



# **New Designs for OXCs with Wavelength Interchanging Capabilities**

Abel Dasyva and Delfin Montuno  
MTTP

# Overview

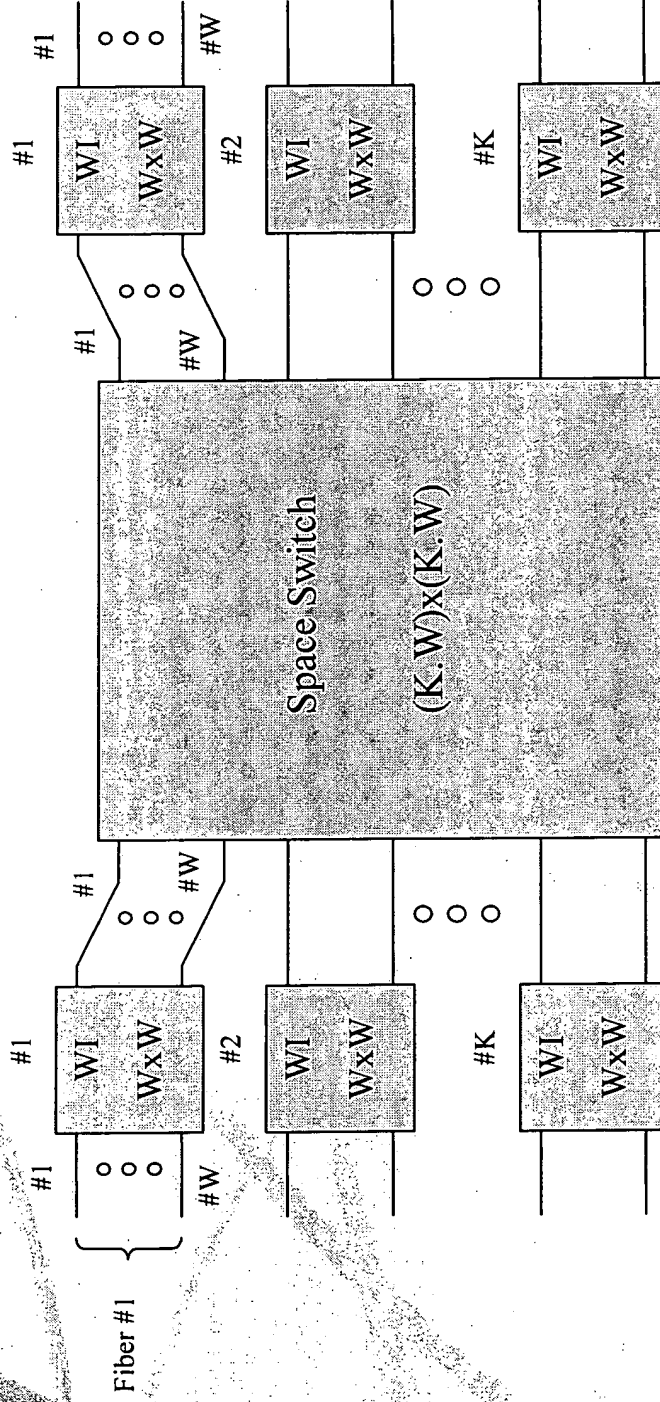
- Importance of wavelength-interchanging OXCs (WIXCs)
- Previous designs for WIXCs
- Problems associated with previous methods
- New design philosophy for WIXCs
- Banyan switch architectures
- Butterfly inter-stage connection pattern using wave-mixers
- Monotonic wavelength-conversion
- Perfect shuffle inter-stage connection pattern based on PFM
- HW requirements of banyan wavelength-inter-changers designed with the new method
- Future work

# Role of WIXCs

- Wavelength-compliance at network boundaries
- Bandwidth provisioning
  - To reduce channel blocking
  - To ease provisioning (simpler Qos routing)
- Contention resolution
  - Deflection routing in optical packet switching networks

# Previous Designs for WIXCs 1/3

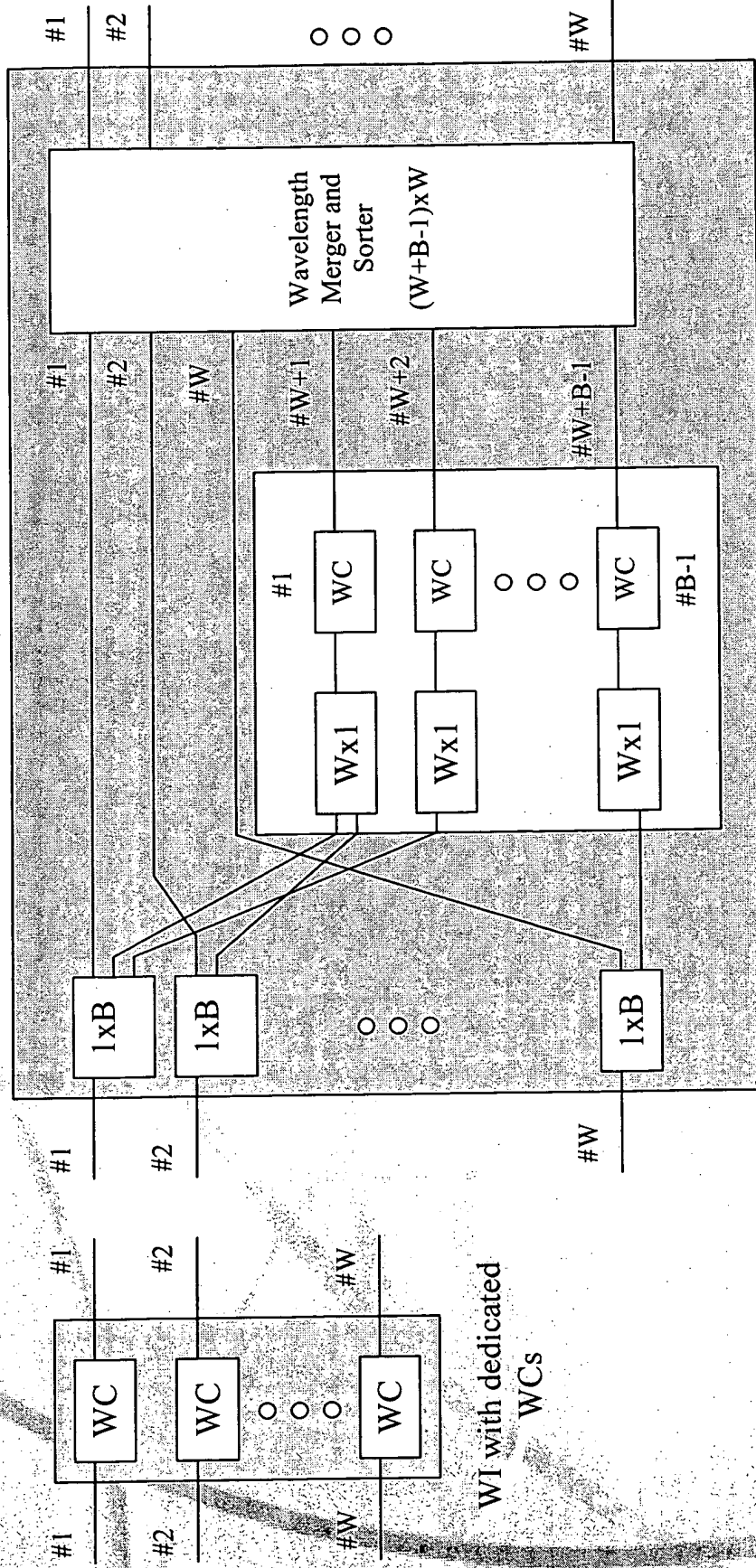
- Ingress/egress wavelength-interchange





# Previous Designs for WIXCs 2/3

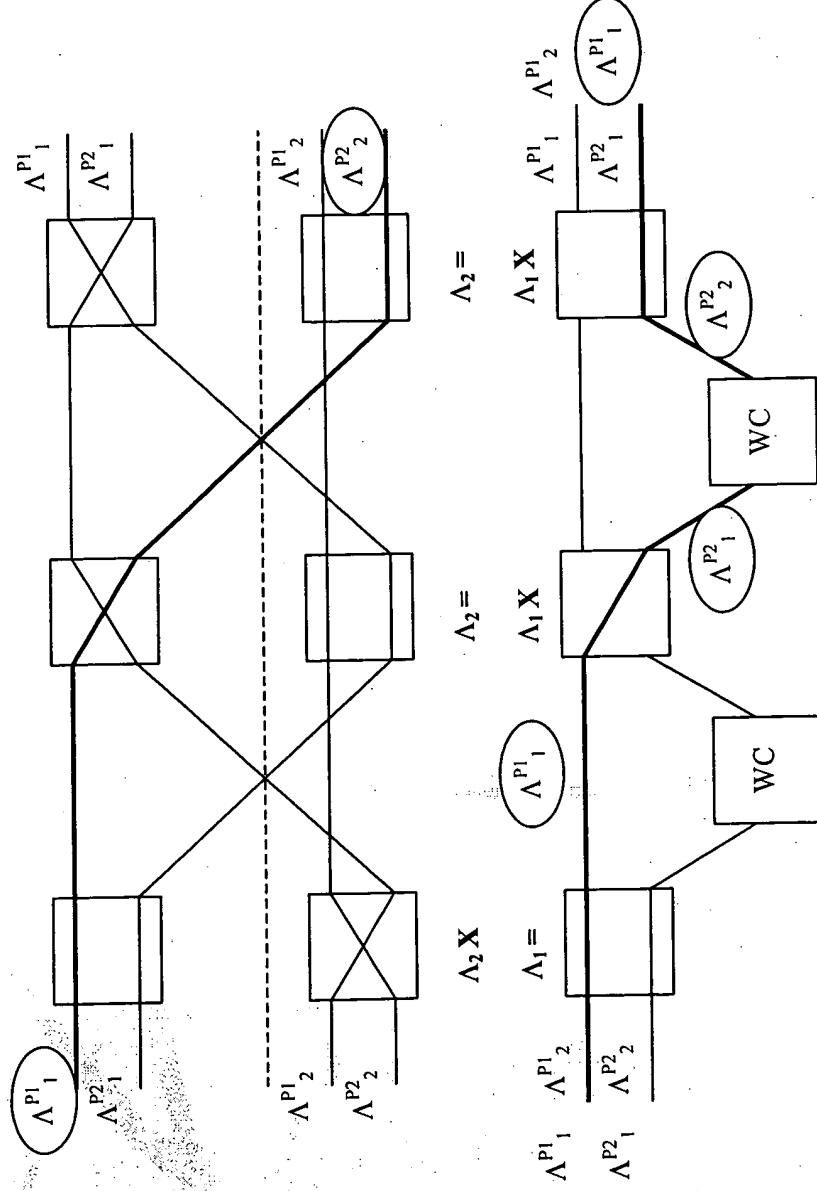
- Some WI designs



WC: Wavelength-converter

# Previous Designs for WIXCs 3/3

- Use of wavelength-space transformations
- At each stage, switching occurs both in the space and in the wavelength domain
- The resulting number of needed converters is high



# Problems associated with Previous Solutions

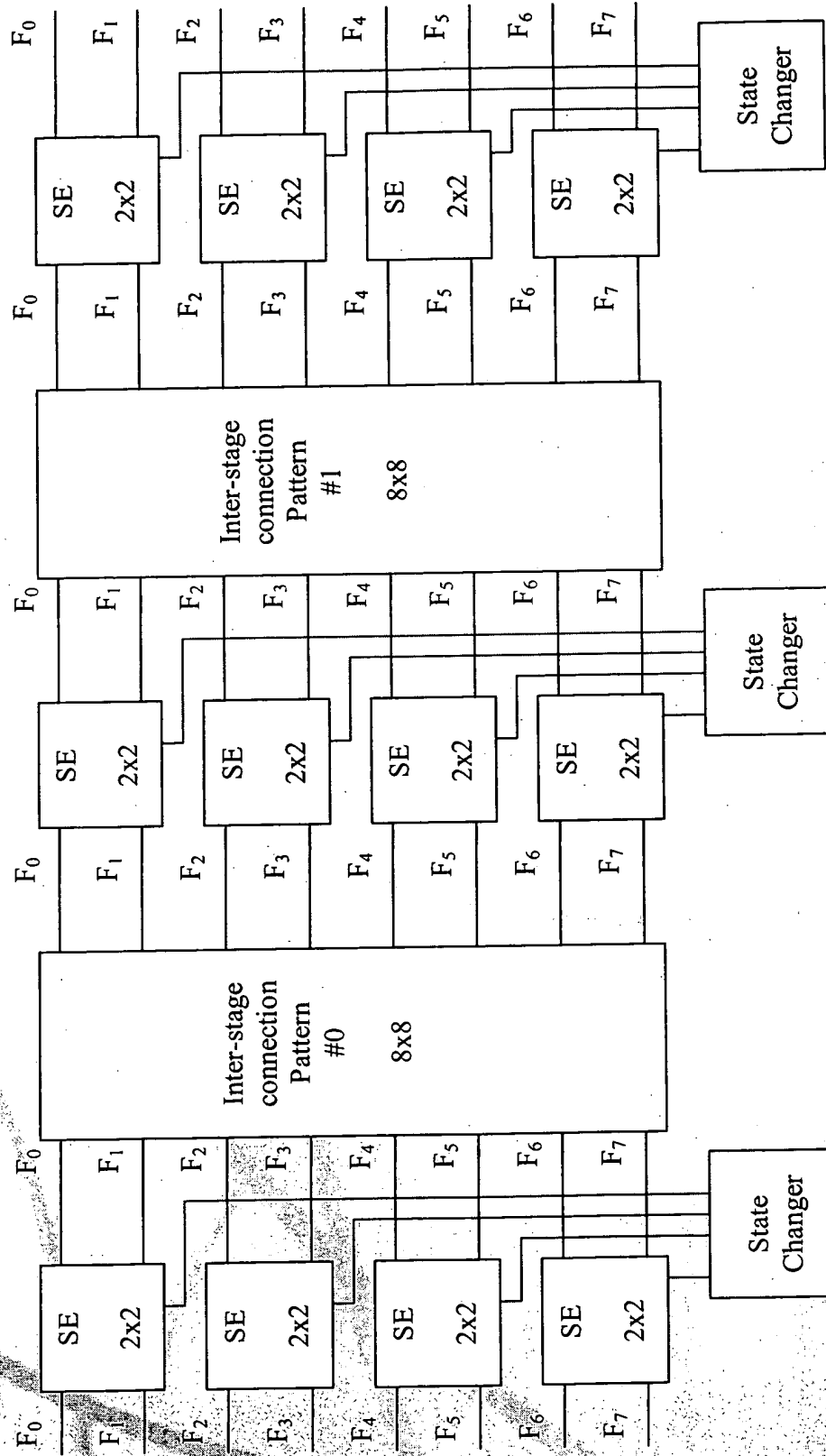
- No systematic method to build wavelength inter-connection networks with arbitrary HW requirements or blocking performance
- Poor use of the properties of wave-mixing devices
- Expensive HW requirements for wavelength conversion devices (the design for a rearrangeable Benes type WIXC still uses  $W/2$  WM devices per interface)

# New Design Philosophy 1/4

- Clear separation of the wavelength-switching domain from the other domains (space and time)
- Wavelength-space-wavelength transformation
- Use of transparent parametric wavelength-conversion
- Separate the design of switch elements (SEs) from the design of specific Inter-Stage Connection (ISC) patterns
- Design of ISC patterns through a new method based on monotonic WC

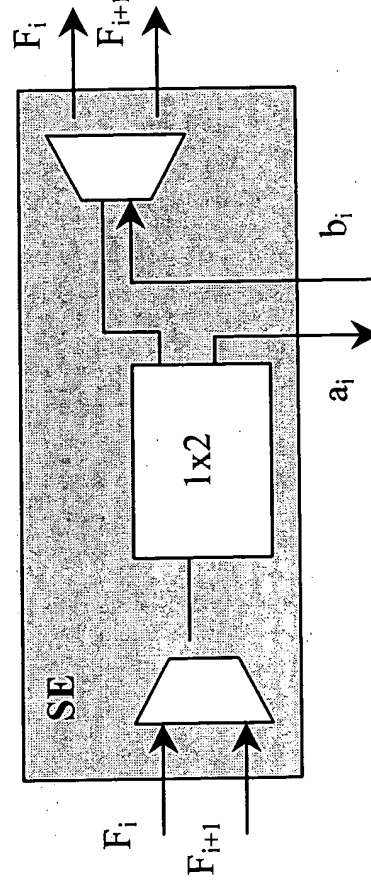
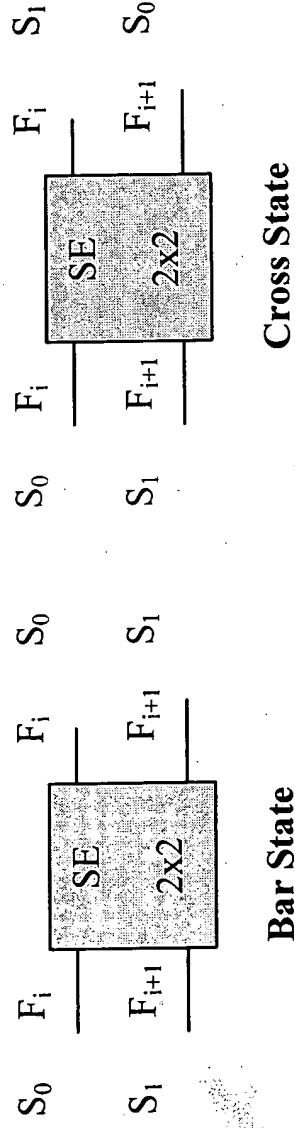
# New Design Philosophy 2/4

- Example in the wavelength domain



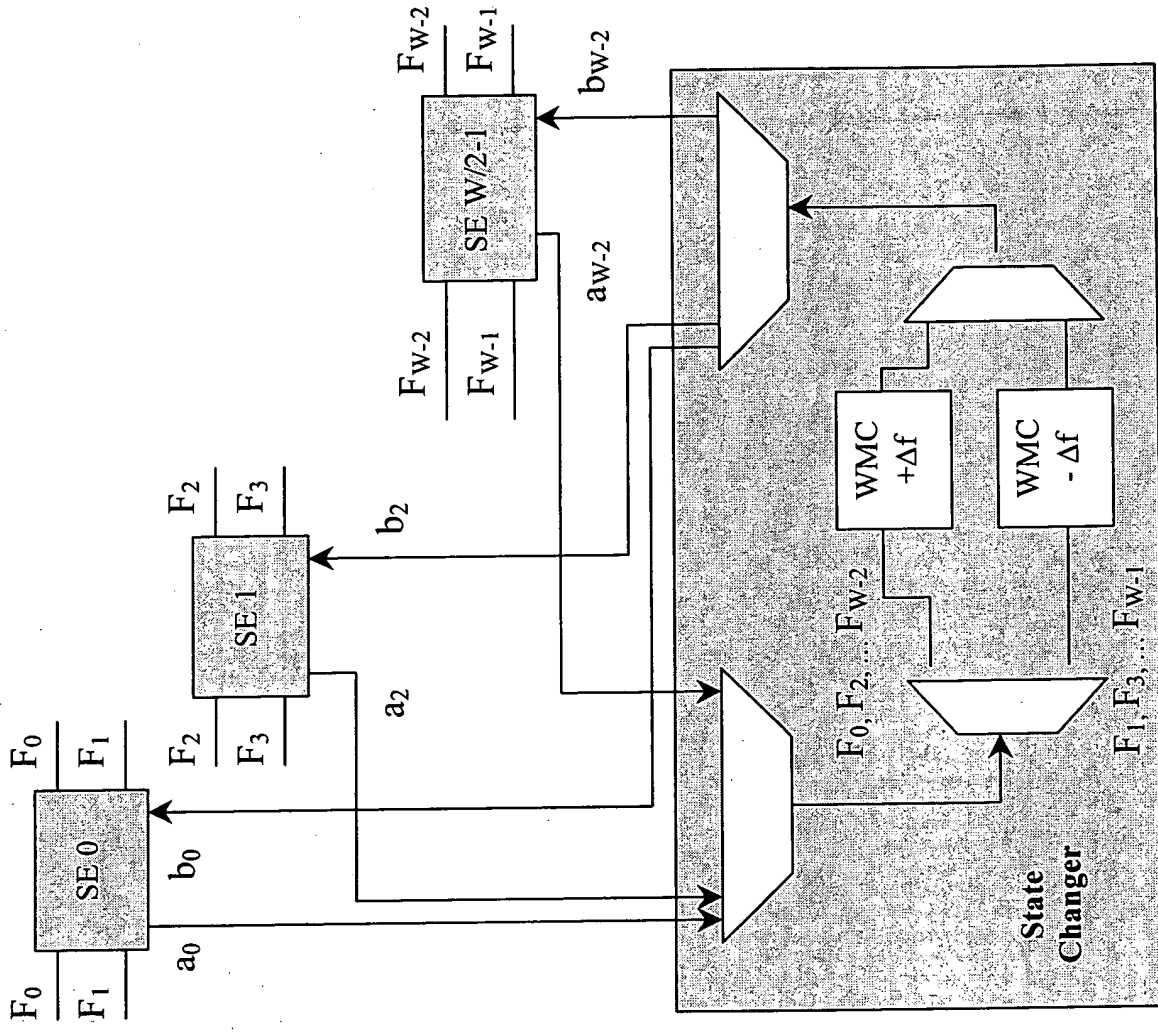
# New Design Philosophy 3/4

- Design of 2x2 SEs



# New Design Philosophy 4/4

- Design of 2x2 SEs



# Banyan Switch Architectures 1/2

Basic ISC patterns described in terms of bit patterns:

$$\sigma_h(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_{h-1} \dots a_0 a_h, 0 \leq h \leq n-1$$

$$\sigma_h^{-1}(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_0 a_h \dots a_1, 0 \leq h \leq n-1$$

$$\beta_h(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_0 a_{h-1} \dots a_1 a_h, 0 \leq h \leq n-1$$

$$j(a_{n-1} \dots a_0) = a_{n-1} \dots a_0, 0 \leq h \leq n-1$$

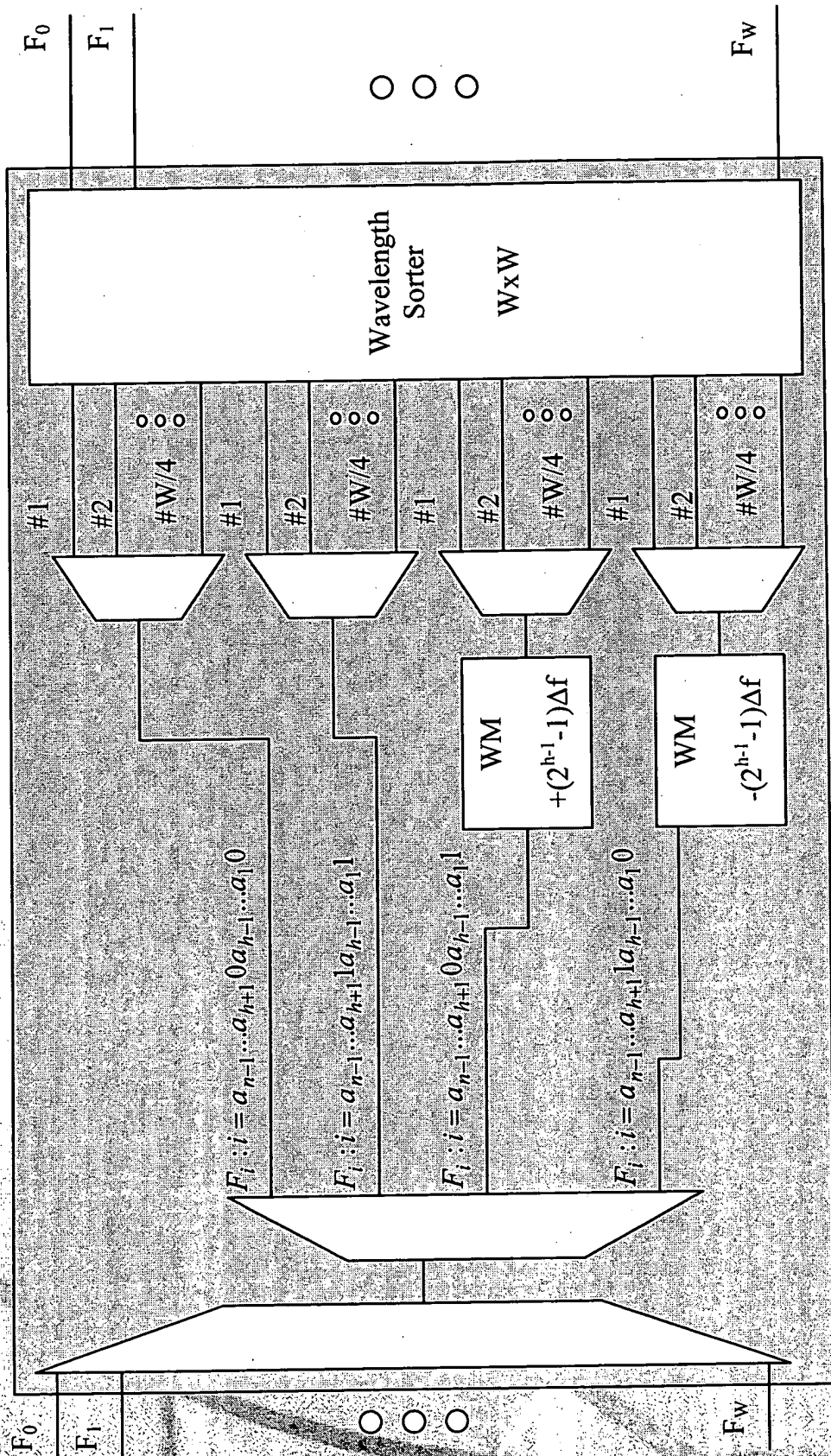


# Banyan Switch Architectures 2/2

Networks:

	$P(0)$	$P(h), 0 < h < n$	$P(n)$
Omega	$\sigma_{n-1}$	$\sigma_{n-1}$	J
Omega <sup>-1</sup>	J	$\sigma_{n-1}^{-1}$	$\sigma_{n-1}^{-1}$
SW-banyan	J	$\beta_h$	J
SW-banyan	J	$\beta_{n-h}$	J
n-cube	$\sigma_{n-1}$	$\beta_{n-h}$	J
n-cube <sup>-1</sup>	J	$\beta_h$	$\sigma_{n-1}^{-1}$
Baseline	J	$\sigma_h^{-1}$	J

# Butterfly ISC Pattern based on Wave-Mixing

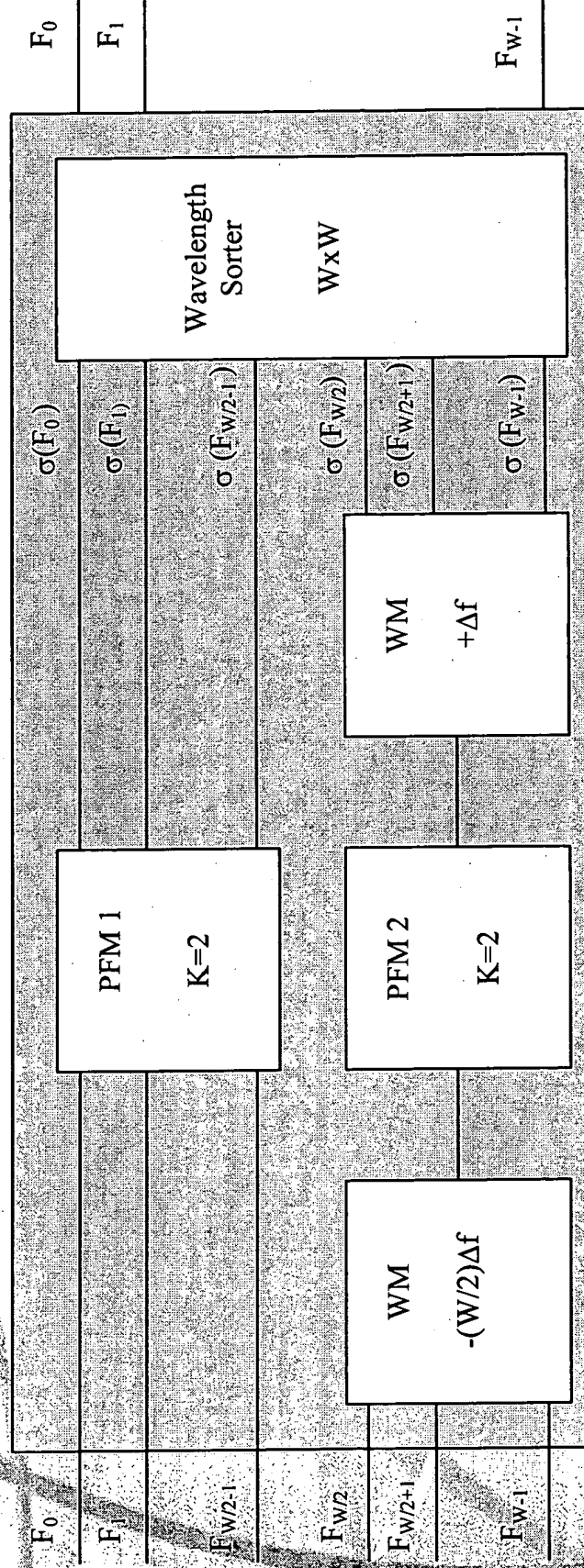


# Monotonic WC

- Wavelength-mapping operation that preserves or simply inverts the ordering relationships of wavelengths
- Devices implementing monotonic WC may be implemented with a number of wave-mixing components of the order of the logarithm of the number of wavelengths ( $O(\log(W))$ )
- Pseudo frequency multiplication
  - Mapping of  $F_i$  to  $F_{k,i}$ , for any  $i$
  - PFM is a specific example of monotonic WC

# Perfect Shuffle ISC Pattern based on PFM

- Perfect frequency shuffler using  $O(\log(W))$  wave mixing devices



# HW Requirements of Banyan Wls Designed with the New Approach

- New method

	Number of WM Devices used
Omega	$O(\log(W)^2)$
Omega <sup>-1</sup>	$O(\log(W)^2)$
SW-banyan	$O(\log(W))$
SW-banyan	$O(\log(W))$
n-cube	$O(\log(W))$
n-cube <sup>-1</sup>	$O(\log(W))$
Baseline	$O(\log(W)^2)$

- Previous approaches usually require a number of WMs of the order of  $W$

# Future Work

- Design of WIXCs with arbitrary properties in terms of the following characteristics
  - Blocking properties: rearrangeable, wide-sense non-blocking, strictly non-blocking
  - Inter-stage connection density: full/partial connection
- Impact on the transmission quality (noise, cross-talk, dispersion, ...etc), and performance requirements for WM devices to be used in the new approach
- Multicast support
- Switches with several multiplexing levels (time, wavelength and space)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT B**

**INVENTION DISCLOSURE REVIEW SUMMARY/DISPOSITION**

Initial Review Date: \_\_\_\_\_

Disclosure No.: <u>1294620</u>	Product Group: _____
Title of Disclosure: <u>Scalable Wavelength-interchanges</u>	Business Unit: <u>EB75</u>
Standards Related: <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes	<input checked="" type="checkbox"/> Nortel Inventors only
Applicable Standards: _____	<input type="checkbox"/> Nortel and Contractor Inventors
Technology Areas: <u>Optical switch fabric</u>	Product/Project: _____
Strategic Focus Area: <u>Optical networks</u>	<u>MTTP</u>

**REVIEW SUMMARY**

**GIST OF THE INVENTION**

Summarize within a few lines what the major thrust of the invention is, e.g. a software program to be added to voice networks, such as Meridian, which will allow instantaneous translations from French to English.

new architecture for interstage connection patterns

**BENEFIT FROM THE INVENTION**

Summarize within a few lines how the invention will benefit its target benefactor, e.g. subscribers will be able to retrieve multi-lingual messages instantaneously without having to employ additional time consuming translation processes which may not be readily available.

fewer active components needed

**Ranking/Scoring Data**

- a. Technological Thrust: 3 (0-3)
- b. Inventive Value: 3 (0-3)
- c. Commercial Value: 3 (0-3)

**OVERALL SCORE:** 9

**FINAL DISPOSITION**

Final Disposition Date: \_\_\_\_\_

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> File Patent Application -- Target Filing Date: _____ | <input type="checkbox"/> Close without filing                  |
| <input type="checkbox"/> Combine with/include in Disclosure No.: _____                   | <input type="checkbox"/> Reconsider/Table (see comments below) |
| <input type="checkbox"/> Other (e.g., publish, Tech. Licensing, etc.)                    |  |

Comments: \_\_\_\_\_

Critical Filing Date (If Applicable): \_\_\_\_\_

Foreign Filing Potential: ☐ No ☒ Yes

(circle) Tier 1  
(UK, DE, FR, CA)

Tier 2: \_\_\_\_\_  
(Please specify)

(Revised) \_\_\_\_\_



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT C**

Kim LaRocca  
Outsource Administrator  
Intellectual Property Law Group  
600 Technology Park Drive, MS E65-60-403  
Billerica, Massachusetts 01821-5501  
Tel 978-288-6754 Fax 978-288-6543  
[www.nortelnetworks.com](http://www.nortelnetworks.com)



*How the world shares ideas.*

**NORTEL NETWORKS CONFIDENTIAL &  
PRIVILEGED COMMUNICATION**

August 2, 2000

CONFIDENTIAL

VIA FACSIMILE 202 778-2201, ORIGINAL NOT SENT

Thomas E. Anderson, Esq.  
Hunton & Williams  
1900 K Street, N.W.  
Washington, DC 20006-1109

Re: **Invention Docket No.: 12946RO**  
**Title: Scalable Wavelength-Interchangers Based on Frequency Comb-Shifters**  
**Required Filing Date: November 2, 2000**

Dear Attorney Anderson:

Nortel Networks would like to retain your firm to prepare and file in the United States Patent and Trademark Office (USPTO) a patent application directed to the invention disclosed in the enclosed invention disclosure by the above-referenced filing date. The application should be prepared according to Nortel Networks guidelines, and in accordance with the predetermined fee we have agreed with your firm; for the total fee of about [REDACTED] exclusive of drawing(s) and USPTO filing fees. If you are unable to perform the requested work, please advise me immediately.

In addition to the invention disclosure, an invention disclosure Review Summary document is enclosed for your consideration. We request that you contact the primary inventor, Abel Dasylva, at (613) 763-5034 within two weeks of receiving this letter. Please ensure that the inventor(s) are advised of their responsibilities regarding their duty of candor to the USPTO, as well as any other relevant rules and/or laws including the best mode requirement.

We also ask that you quickly review the contents of this letter and its enclosures to ascertain whether or not any bar dates appear to be imminent. If so, we ask that you develop a plan of action to protect Nortel Networks' intellectual property rights in the invention disclosure.

Questions pertaining to substantive issues associated with the application should be addressed with the responsible attorney at (978) 288-6997, while administrative issues associated with the application should be addressed with me. Please be sure that all communications associated with the application, including billing statements and the application itself bear the above-referenced disclosure number.

Please send a substantially complete and final draft of the application to me along with a completed Nortel Networks Outsource's Patent Application Checklist at least 10 days prior to the above-referenced filing date to provide Nortel Networks' Intellectual Property Law Group sufficient opportunity to review the application prior to filing. You should seek to obtain the signatures on the formal papers from all inventors directly.

August 2, 2000  
Thomas E. Anderson, Esq  
Page 2

Upon filing the application with the USPTO, immediately fax a copy of the application transmittal letter and Declaration to me, so that we have a record that the application has been filed. Thereafter, please send me a hardcopy of the application as filed along with an electronic copy in Microsoft Word 6.0 readable format on a 3 1/2" floppy disk.

Please confirm receipt of this letter via facsimile. Should you have any questions, please call me at 978-288-6754.

Very truly yours,



Kim LaRocca

Enclosures:

cc: Invention Disclosure No.: 12946RO  
Review Summary

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT D**

**HUNTON &  
WILLIAMS**

1900 K STREET, N.W.  
WASHINGTON, D.C. 20006-1109

TEL 202 • 955 • 1500  
FAX 202 • 778 • 2201

THOMAS E. ANDERSON  
DIRECT DIAL: 202 • 955 • 1808  
EMAIL: andersont@hunton.com

FILE NO: 57983.000018

December 7, 2000

**VIA FACSIMILE**

Mr. Abel C. Dasyuva  
Nortel Networks  
21 Richardson Side Road  
M/S 117D1F04  
Kanata ON K2K 2C1  
Canada

Re: New U.S. Patent Application  
Title: "SCALABLE WAVELENGTH-INTERCHANGERS BASED  
ON FREQUENCY COMB-SIFTERS"  
Your Ref.: 12946RO  
Our Ref.: 57983-000018

Dear Abel:

Enclosed please find a copy of a draft of the above-identified patent application for your review. The enclosed copy is exactly the same as the one that I emailed to you earlier.

Please review this application to determine if it accurately and adequately describes your invention, noting on the enclosed draft any comments or suggestions you may have.

After you have completed your review, please return the draft to me. The patent application will then be placed in a condition for filing in the U.S. Patent and Trademark Office (USPTO), and a final version of the patent application will be sent to you for execution.

Also, pursuant to USPTO rules, a statement must be submitted disclosing to the USPTO all presently known information believed material to the examination of the above-identified patent application. Information is considered material if there is a substantial likelihood that the information would be considered important in deciding patentability. Accordingly, please send for my review all presently known patents, publications, or other published materials relating to the subject invention. Please note that you are not required to do any research to locate information that is not already known by you.

**HUNTON &  
WILLIAMS**

Mr. Abel Dasyuva

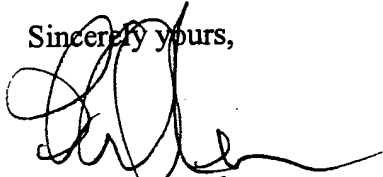
December 8, 2000

Page 2

Accurate and complete disclosure of material information facilitates the examination phase of the patent application, and most importantly, strengthens the presumption of validity accorded any patent issuing thereon.

If you have any questions concerning the review of the patent application or the submission of material information, please do not hesitate to contact me directly at the above-listed number.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'T. Anderson', with a long horizontal flourish extending to the right.

Thomas E. Anderson

TEA/vll

Enclosure

cc: Holmes Anderson (via fax)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT E**

**Anderson, Thomas**

---

**From:** Anderson, Thomas  
**Sent:** Wednesday, December 27, 2000 9:45 PM  
**To:** Abel C. Dasyva (E-mail)  
**Subject:** Your: 12946RO / Our: 57983-000018



3nnr01l.doc



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT F**

**Anderson, Thomas**

---

**From:** Abel Dasyiva [abel@nortelnetworks.com]  
**Sent:** Thursday, December 28, 2000 4:06 PM  
**To:** 'Anderson, Thomas'  
**Cc:** Delfin Montuno  
**Subject:** Filing of invention 12946RO

Thomas,

Delfin and I approve of your filing our invention 12946RO.

Thanks,

-Abel

12/28/00

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT G**



## UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS  
UNITED STATES PATENT AND TRADEMARK OFFICE  
WASHINGTON, D.C. 20231  
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
09/749,946	11/29/2000	2633	710	57983.000018	25	16	2

CONFIRMATION NO. 6810

## FILING RECEIPT



\*OC000000005756560\*

Thomas E. Anderson  
Hunton & Williams  
1900 K Street, N.W.  
Washington, DC 20006-1109

Date Mailed: 02/12/2001

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the PTO processes the reply to the Notice, the PTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).

## Applicant(s)

Abel C. Dasyuva, Residence Not Provided;  
Delfin Y. Montuno, Residence Not Provided;  
Guo-Qiang Wang, Residence Not Provided;

## Continuing Data as Claimed by Applicant

## Foreign Applications

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

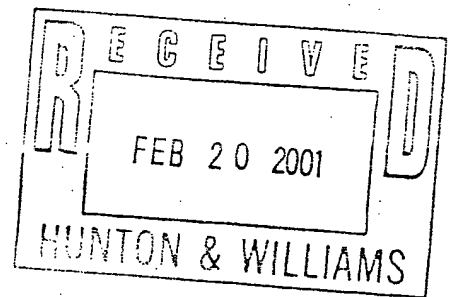
Early Publication Request: No

## Title

Technique for interchanging wavelengths in a multi-wavelength system

## Preliminary Class

359



REVIEWED  
SW

---

Data entry by : GURMU, MULUEMEBET

Team : OIPE

Date: 02/12/2001



**LICENSE FOR FOREIGN FILING UNDER**  
**Title 35, United States Code, Section 184**  
**Title 37, Code of Federal Regulations, 5.11 & 5.15**

**GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 36 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

**NOT GRANTED**

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15 (b).

**PLEASE NOTE the following information about the Filing Receipt:**

- The articles such as "a," "an" and "the" are not included as the first words in the title of an application. They are considered to be unnecessary to the understanding of the title.
- The words "new," "improved," "improvements in" or "relating to" are not included as first words in the title of an application because a patent application, by nature, is a new idea or improvement.
- The title may be truncated if it consists of more than 600 characters (letters and spaces combined).
- The docket number allows a maximum of 25 characters.
- If your application was submitted under 37 CFR 1.10, your filing date should be the "date in" found on the Express Mail label. If there is a discrepancy, you should submit a request for a corrected Filing Receipt along with a copy of the Express Mail label showing the "date in."
- The title is recorded in sentence case.

Any corrections that may need to be done to your Filing Receipt should be directed to:

Assistant Commissioner for Patents  
Office of Initial Patent Examination  
Customer Service Center  
Washington, DC 20231

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT H**



COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: "TECHNIQUE FOR INTERCHANGING WAVELENGTHS IN A MULTI-WAVELENGTH SYSTEM", the specification of which:

(X only one)      (a) \_\_\_\_\_ is attached hereto.  
                              (b)   X   was filed as U.S. Patent Application No. 09/749,946 on December 29, 2000, and was amended on \_\_\_\_\_, 20\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby acknowledge the duty to disclose to the Office all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56, including, for a continuation-in-part application, material information which became available between the filing date of the prior application and the national or international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate, under 35 U.S.C. § 365(a) of any international application(s) designating at least one country other than the United States, or under 35 U.S.C. § 365(b) of any foreign application(s) for patent or inventor's certificate or any international application(s) designating at least one country other than the United States, listed below, and have also identified below any foreign application(s) for patent or inventor's certificate or any international application(s) having a filing date before that of any application on which priority is claimed:

Application No.	Country	Filing Date (MM/DD/YY)	Priority Claimed?
_____	_____	_____	_____

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

Application No.	Filing Date (MM/DD/YY)
_____	_____
_____	_____

I hereby claim the benefit under 35 U.S.C. § 120 of any United States non-provisional application(s) listed below:

Application No.	Filing Date (MM/DD/YY)	Status (Patented, Pending, Abandoned)
_____	_____	_____
_____	_____	_____

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

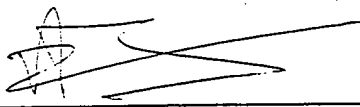
I hereby appoint: Thomas E. Anderson, Registration No. 37,063; Stanislaus Aksman, Registration No. 28,562; Jennifer A. Albert, Registration No. 32,012; David E. Baker, Registration No. 42,285; Scott D. Balderston, Registration No. 35,436; Carl L. Benson, Registration No. 38,378; Bradford Blaise, Registration No. P47,429; Thomas M. Blasey, Registration No. 33, 475; Brian M. Buroker, Registration No. 39,125; Christopher C. Campbell, Registration No. 37,291; Robin C. Clark, Registration No. 40,956; Christopher J. Cuneo, Registration No. 42,450; Patrick A. Doody, Registration No. 35,022; Kevin T. Duncan, Registration No. 41,495; David D'Zurilla, Registration No. 36,776; Ozzie Farres, Registration No. 43,606; Nancy Flint, Registration No., 46,704; Christopher J. Forstner, Registration No. 46,049; James G. Gatto, Registration No. 32,694; George Georgellis, Registration No. 43,632; Paramita Ghosh, Registration No., 42,806; Paul D. Golian,

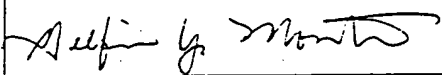
Registration No. 42,951; Charles F. Hollis, Registration No. 40,650; David M. Huntley, Registration No. 40,309; Nancy J. Jensen, Registration No. 45,913; Herbert V. Kerner, Registration No. 42,721; Steven P. Klocinski, Registration No. 39,251; Jonathan D. Link, Registration No. 41,548; J. Michael Martinez, Registration No. 31,178; David H. Milligan, Registration No. 42,893; James R. Miner, Registration No. 40,444; Devin S. Morgan, Registration No. 45,562; Kerry H. Owens, Registration No. 37,412; Andrew J. Ririe, Registration No. 45,597; Robert M. Schulman, Registration No. 31,196; Thomas J. Scott, Jr., Registration No. 27,836; 647 Stuart I. Smith, Registration No. 42,159; Yisun Song, Registration No. 44,487; Raphael A. Valencia, Registration No. 43,216; Rene' Vazquez, Registration No. 38,647; and Scott F. Yarnell, Registration No. 45,245, all of the firm **Hunton & Williams**, 1900 K Street, NW, Washington, DC 20006, as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application, and any provisionals, continuations, continuations-in-part, divisionals, appeals, reissues, substitutions, re-examinations, and extensions thereof, and to transact all business in the United States Patent and Trademark Office connected therewith, to appoint any individuals under an associate power of attorney, and to file and prosecute any international patent application based thereon before any international authorities.

Please address all correspondence and direct all telephone calls to:

Thomas E. Anderson  
Hunton & Williams  
1900 K Street, N.W.  
Washington, D.C. 20006-1109  
telephone (202) 955-1500  
facsimile (202) 778-2201

**NAMED INVENTOR(S):**

1	<b>Full Name</b> Abel C. Dasylyva	<b>Inventor's Signature</b> 	<b>Date</b> 01/30/2001
	<b>Residence (city, state, country)</b> 1-70 Bolton Ottawa, ON Canada K1H 5A5		<b>Citizenship</b> Ivory Coast
	<b>Post Office Address (include zip code)</b> Same as residence		

2	<b>Full Name</b> Delfin Y. Montuno	<b>Inventor's Signature</b> 	<b>Date</b> Jan. 30, 2001
	<b>Residence (city, state, country)</b> 122 Knudson Drive Kanata, ON Canada K2K 2L8		
	<b>Citizenship</b> CANADA		
	<b>Post Office Address (include zip code)</b> Same as residence		

3	<b>Full Name</b> Guo-Qiang Wang	<b>Inventor's Signature</b> <i>G. Q. Wang</i>	<b>Date</b> <i>Jan 30, 2001</i>
	<b>Residence (city, state, country)</b> 175 Longshire Circle Nepean, ON Canada K2J4L2	<b>Citizenship</b> Canada	
	<b>Post Office Address (include zip code)</b> Same as residence		



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of: :  
: Abel C. Dasyuva et al. : Group Art Unit: 2633  
: :  
Appln. No.: 09/749,946 :  
: Examiner: Agustin Bello  
Filed: December 29, 2000 :  
: :  
For: TECHNIQUE FOR INTERCHANGING :  
WAVELENGTHS IN A MULTI- :  
WAVELENGTH SYSTEM :

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION UNDER 37 C.F.R. § 1.131**

Sir:

I, Guo-Qiang Wang, hereby declare that I am a co-applicant in the above-identified patent application and that I am also a co-inventor of the invention that is described and claimed in the above-identified patent application. I also hereby declare that prior to July 31, 2000, my co-inventors and I conceived of the invention that is described and claimed in the above-identified patent application as evidenced by the following:

1. Prior to July 31, 2000, my co-inventors and I conceived of the invention in Canada. At the time of the invention, I owed a duty of assignment of the invention to Nortel Networks Limited (hereinafter "Nortel").

2. Shortly after my co-inventors and I conceived of the invention, my co-inventors and I submitted a description of the invention to the appropriate Nortel patent review committee for purposes of obtaining approval to file a patent application for the invention. A date redacted copy of the description of the invention (i.e., our invention disclosure) is attached hereto as Exhibit A.

3. To the best of my knowledge, the Nortel patent review committee followed its standard procedures in reviewing and subsequently approving of the filing of a patent application based upon our invention disclosure. A date redacted copy of an internal Nortel memo approving the filing of the patent application is attached hereto as Exhibit B.

4. On August 2, 2000, our invention disclosure was forwarded to one of Nortel's outside patent attorneys for preparation of a patent application. A copy of a transmittal letter authorizing preparation of a patent application is attached hereto as Exhibit C.

5. Between August 2, 2000, and December 7, 2000, my co-inventors and I had discussions regarding our invention disclosure with the outside patent attorneys, and provided additional supporting materials to the outside patent attorneys, all intended to assist the outside patent attorneys in preparing a patent application for the invention.



6. On December 7, 2000, one of my co-inventors was forwarded a draft of the patent application. A copy of the transmittal letter sending the draft is attached hereto as Exhibit D.

7. On December 27, 2000, one of my co-inventors was forwarded a final draft of the patent application. A copy of the transmittal email sending the final draft is attached hereto as Exhibit E.

8. On December 28, 2000, my co-inventors and I approved of the filing of the final draft of the patent application. A copy of the transmittal email sending our approval is attached hereto as Exhibit F.

9. On December 29, 2000, the above-identified patent application was filed. A copy of the filing receipt for the application is attached hereto as Exhibit G.

10. On January 30, 2001, I executed the above-identified patent application. A copy of my signed declaration is attached hereto as Exhibit H.

I further hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

United States Code, and that such willful false statements may  
jeopardize the validity of the application or any patent issued  
thereon.

DECLARANT:

G. Q. Wang  
Guo-Qiang Wang

Date:

Sept 14, 2005

57983.000018 WASHINGTON 541567v1

4

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT A**

**Nortel Networks Confidential & Privileged Information**

## Invention Disclosure Submission Reply

<b>Disc No:</b>	12946RO	<b>Received Date:</b>	
<b>Disclosure Title:</b>	Scalable wavelength-interchangers based on frequency comb-shifters		

### Inventors

Global ID	Name	Work Info	Home Info
053383 8	HR Name: DASYLVA, ABEL C Known As: ABEL	Location: 21 RICHARDSON SIDE ROAD Dept: 0V13 Phone: 3935034 Ext Phone: 613-763-5034 Fax: 613-763-5692 Ext Fax: 613-763-5692 MailStop: 117D1F04 Citizenship:	Address: 1-70 BOLTON OTTAWA, ON CANADA K1H5A5 Phone: (613)7635034
156217 9	HR Name: MONTUNO, DELFIN Y Known As: DELFIN	Location: 21 RICHARDSON SIDE ROAD Dept: 0V12 Phone: 3933116 Ext Phone: (613) 763-3116 Fax: (ESN)389-1140 Ext Fax: (613) 768-1140 MailStop: 117D1D06 Citizenship: CANADA	Address: 122 KNUDSON DRIVE KANATA, ON CANADA K2K2L8 Phone: (613)5925295

### Attachments

<End of Attachments>

<b>Were there additional inventors involved:</b>	yes	<b>Was there contact with any external parties:</b>	no
<b>Name of Supervisor or Divisional Head:</b>	<b>Name of VP:</b>		
GUO-QUANG WANG	KENT FELSKE		
<b>LOB:</b>	SP&C	<b>Business Unit:</b>	Core Networks
<b>Conception Date:</b>			
<b>Has this invention been discussed with others? If so, please complete:</b>			
<b>Inside Nortel - Whom?</b>	DOMINIC GOODWILL, STAN XAVIER	<b>Outside Nortel - Whom?</b>	
<b>Inside Nortel - When?</b>		<b>Outside Nortel - When?</b>	
<b>NDA:</b>	yes		

# Nortel Networks Confidential & Privileged Information

Are you aware of any imminent future disclosures? Please provide dates and details:	
Keywords for Searching:	Products that will use this invention:
	All-optical cross-connects with wavelength-interchanging capabilities
Does this invention arise from any arrangement involving an external organization?	
Is this invention relevant to a Standards Activity?	Internal Funding Project #:
no	8127

## Technical Information

### Brief Description of the Invention:

We describe a new technique to design wavelength-interchanging OXCs, that use a number of wave-mixing converters of the order of the logarithm of the number of wavelengths. These new OXCs minimize the required number of wavelength-converters by the use of frequency comb-shifters.

### Problem Solved by the Invention:

-Design of wavelength-interchanging OXCs with a minimum number of wave-mixing devices, i.e. a number of the order of the logarithm of the number of wavelengths.

### Solutions that have been tried and why they didn't work:

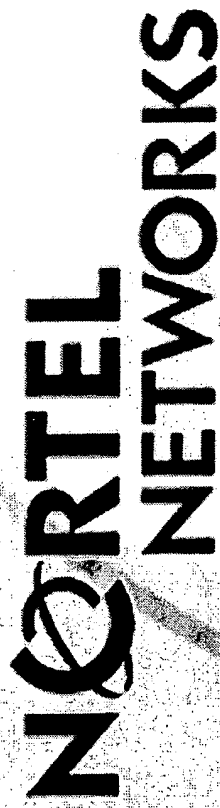
-Dedicated wavelength-converters-Use of wavelength-space transformation equivalent to Marcus time-space transformation  
Problem: The number of wavelength converters is of the order of the number of wavelengths.

### Specific elements or steps that solved the problem and how they do it:

-Design of switch elements sharing state changers based on frequency comb-shifters-Design of the banyan butterfly inter-connection pattern using frequency comb-shifters

### Commercial value of the invention to Nortel and Nortel's major competitors:

Performance advantages:-expected quality of transmissions better than other solutions  
More economical switch fabrics from the point of view:-The number of wave-mixing devices-Power consumption-Overall costs



---

# **New Designs for OXCs with Wavelength Interchanging Capabilities**

**Abel Dasyva and Delfin Montuno  
MTTP**

# Overview

- Importance of wavelength-interchanging OXCs (WIXCs)
- Previous designs for WIXCs
- Problems associated with previous methods
- New design philosophy for WIXCs
- Banyan switch architectures
- Butterfly inter-stage connection pattern using wave-mixers
- Monotonic wavelength-conversion
- Perfect shuffle inter-stage connection pattern based on PFM
- HW requirements of banyan wavelength-inter-changers designed with the new method
- Future work

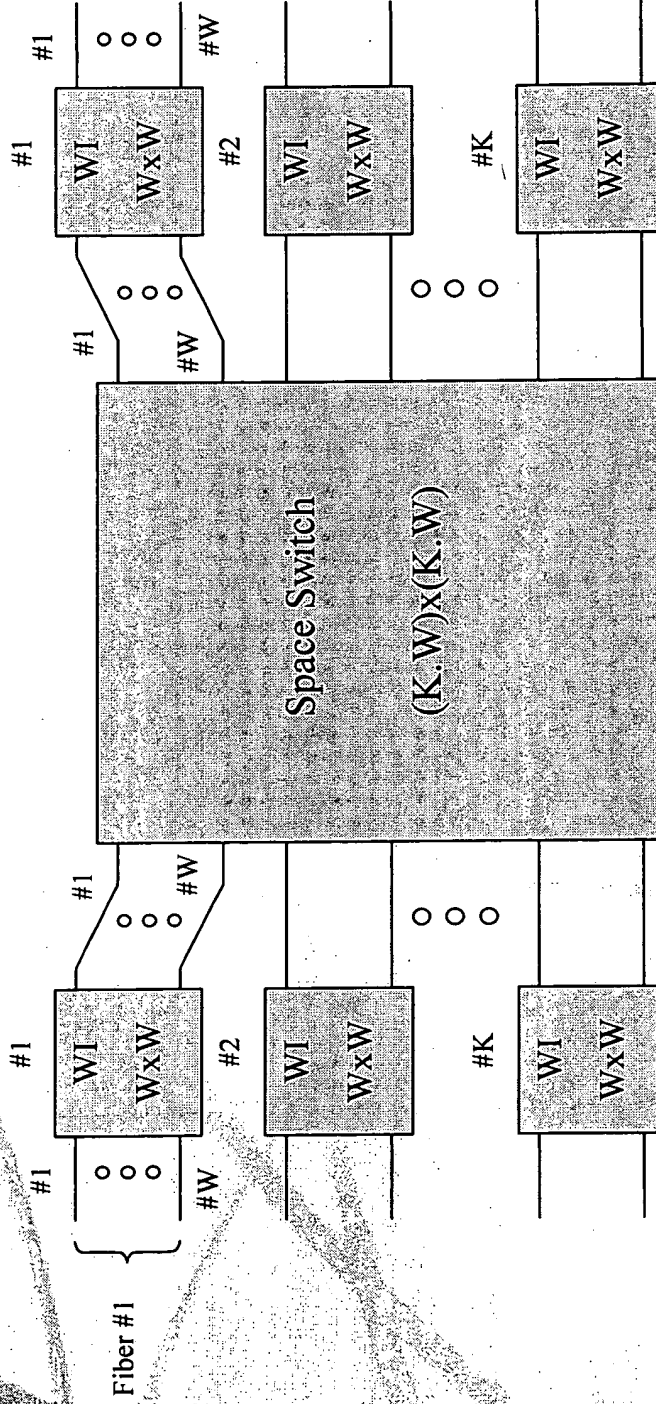
# Role of WIXCs

- Wavelength-compliance at network boundaries
- Bandwidth provisioning
  - To reduce channel blocking
  - To ease provisioning (simpler Qos routing)
- Contention resolution
  - Deflection routing in optical packet switching networks



# Previous Designs for WIXCs 1/3

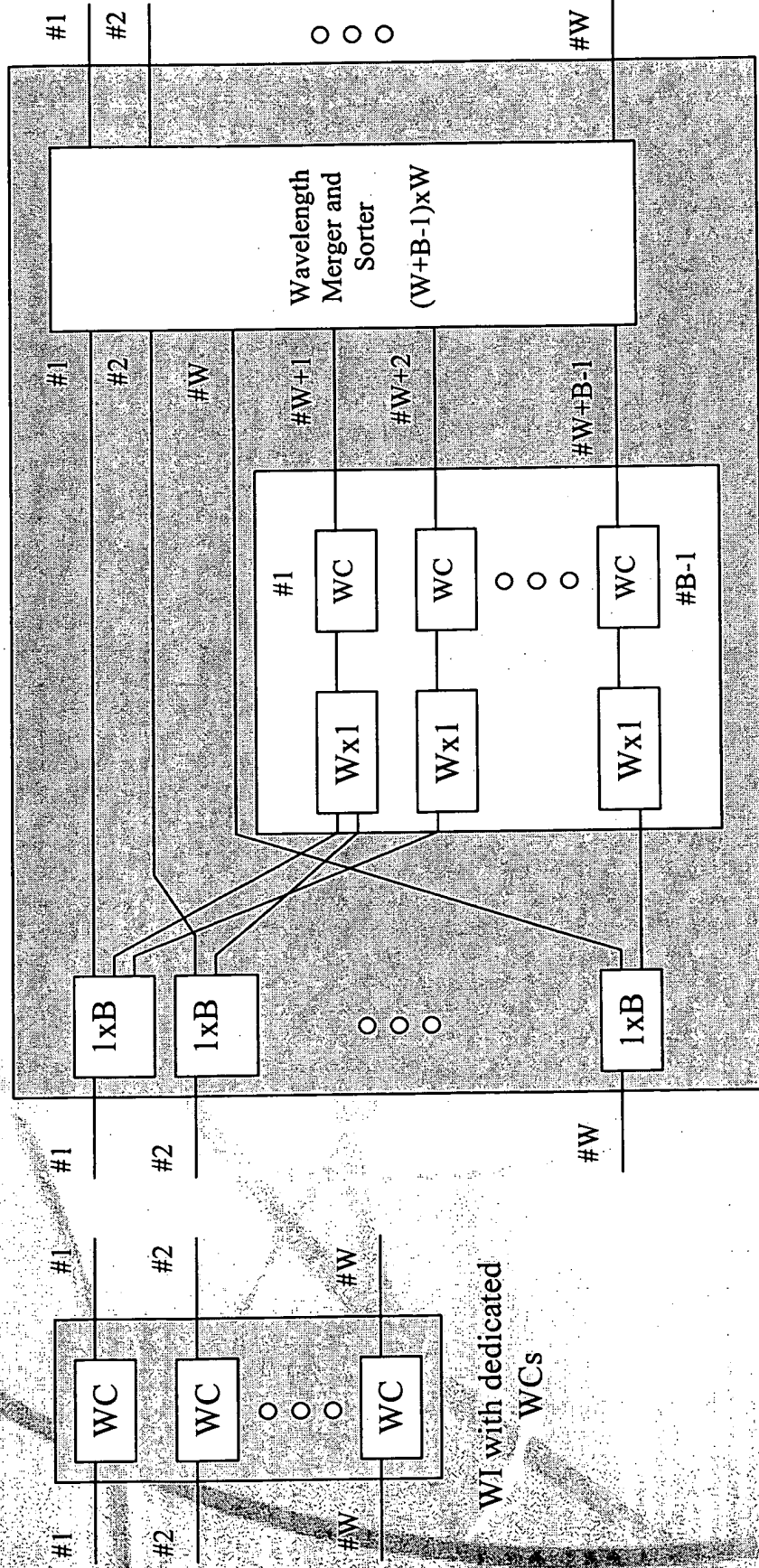
- Ingress/egress wavelength-interchange



WI: Wavelength-interchanger

# Previous Designs for WIXCs 2/3

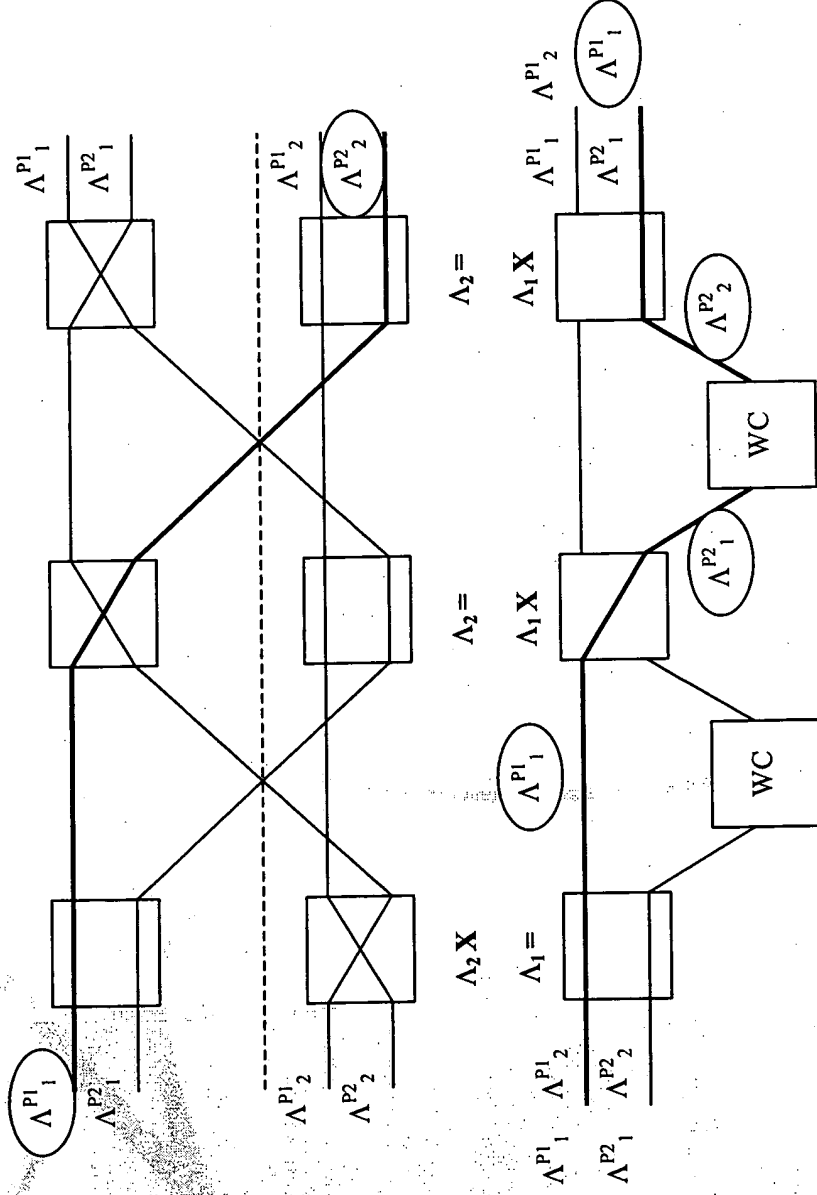
- Some WI designs



WC: Wavelength-converter

# Previous Designs for WIXCs 3/3

- Use of wavelength-space transformations
- At each stage, switching occurs both in the space and in the wavelength domain
- The resulting number of needed converters is high



# Problems associated with Previous Solutions

- No systematic method to build wavelength inter-connection networks with arbitrary HW requirements or blocking performance
- Poor use of the properties of wave-mixing devices
- Expensive HW requirements for wavelength conversion devices (the design for a rearrangeable Benes type WXC still uses  $W/2$  WM devices per interface)

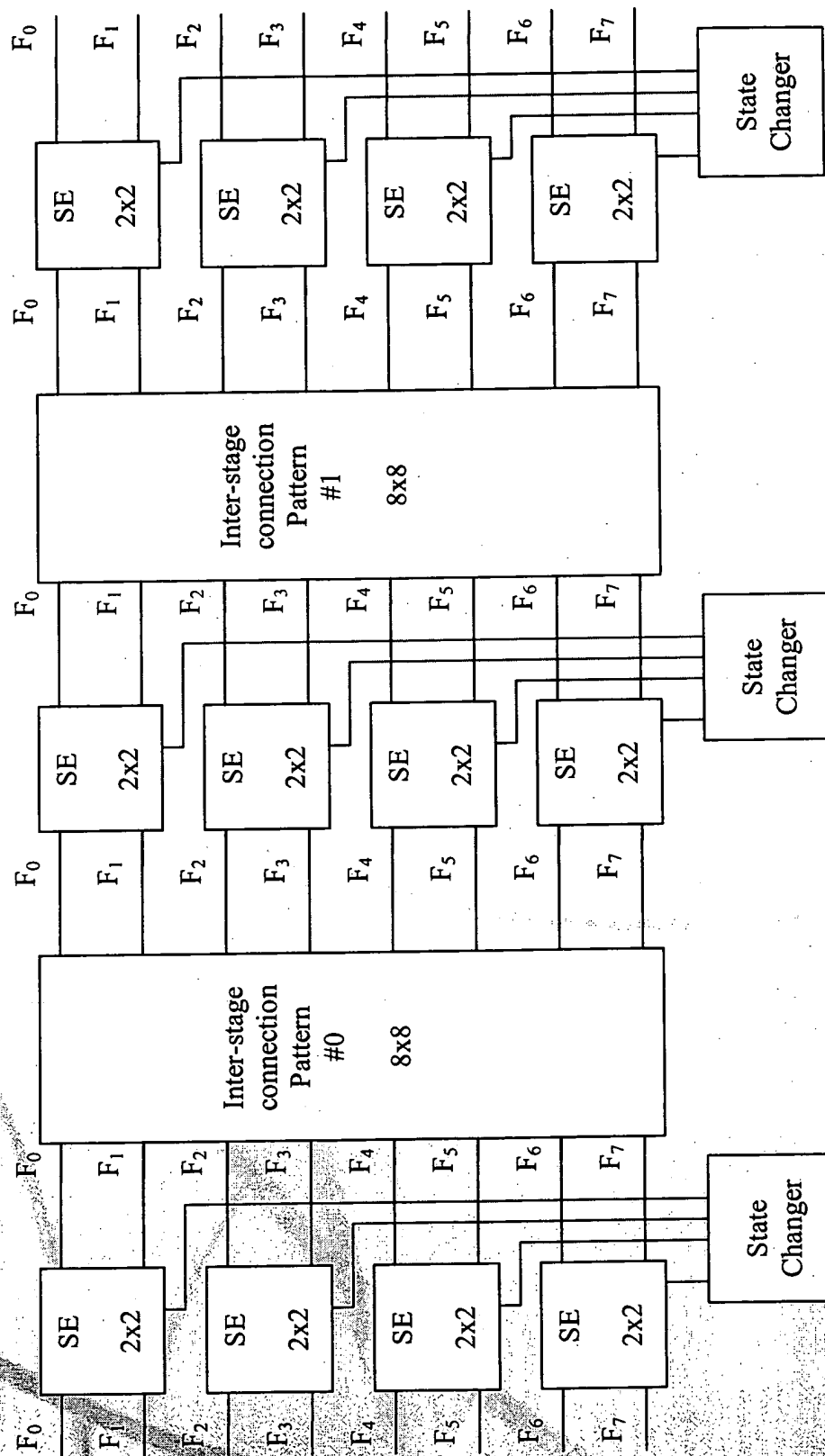
# New Design Philosophy 1/4

- Clear separation of the wavelength-switching domain from the other domains (space and time)
- Wavelength-space-wavelength transformation
- Use of transparent parametric wavelength-conversion
- Separate the design of switch elements (SEs) from the design of specific Inter-Stage Connection (ISC) patterns
- Design of ISC patterns through a new method based on monotonic

WC

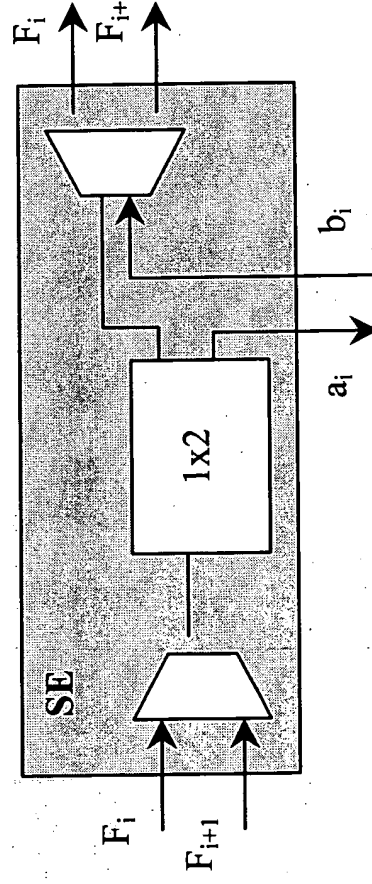
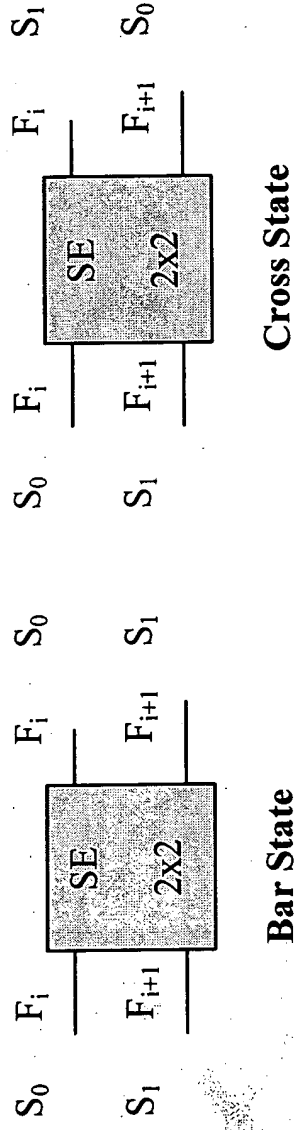
# New Design Philosophy 2/4

- Example in the wavelength domain



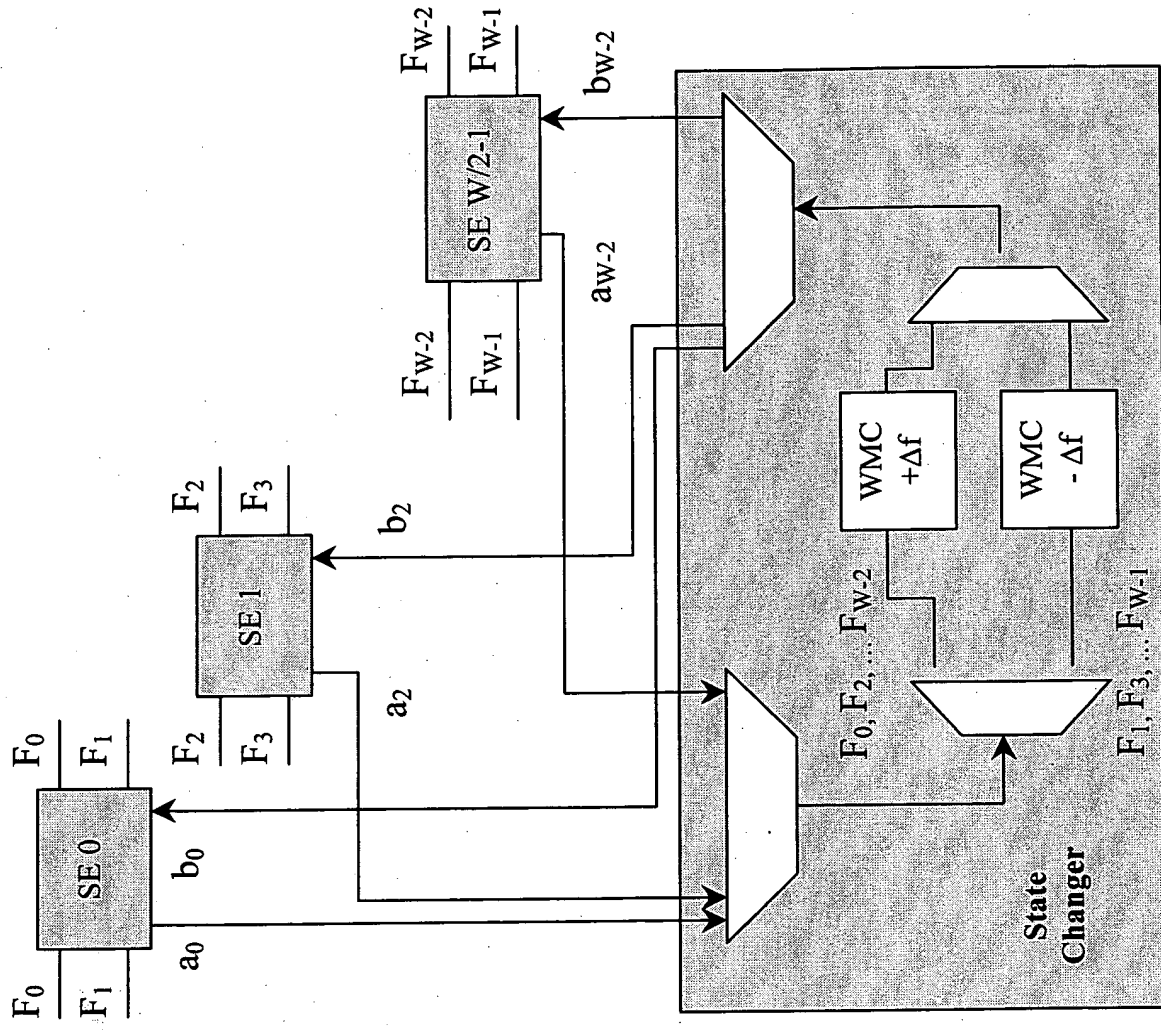
# New Design Philosophy 3/4

- Design of 2x2 SEs



# New Design Philosophy 4/4

- Design of 2x2 SEs





# Banyan Switch Architectures 1/2

Basic ISC patterns described in terms of bit patterns:

$$\sigma_h(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_{h-1} \dots a_0 a_h, 0 \leq h \leq n-1$$

$$\sigma_h^{-1}(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_0 a_h \dots a_1, 0 \leq h \leq n-1$$

$$\beta_h(a_{n-1} \dots a_0) = a_{n-1} \dots a_{h+1} a_0 a_{h-1} \dots a_1 a_h, 0 \leq h \leq n-1$$

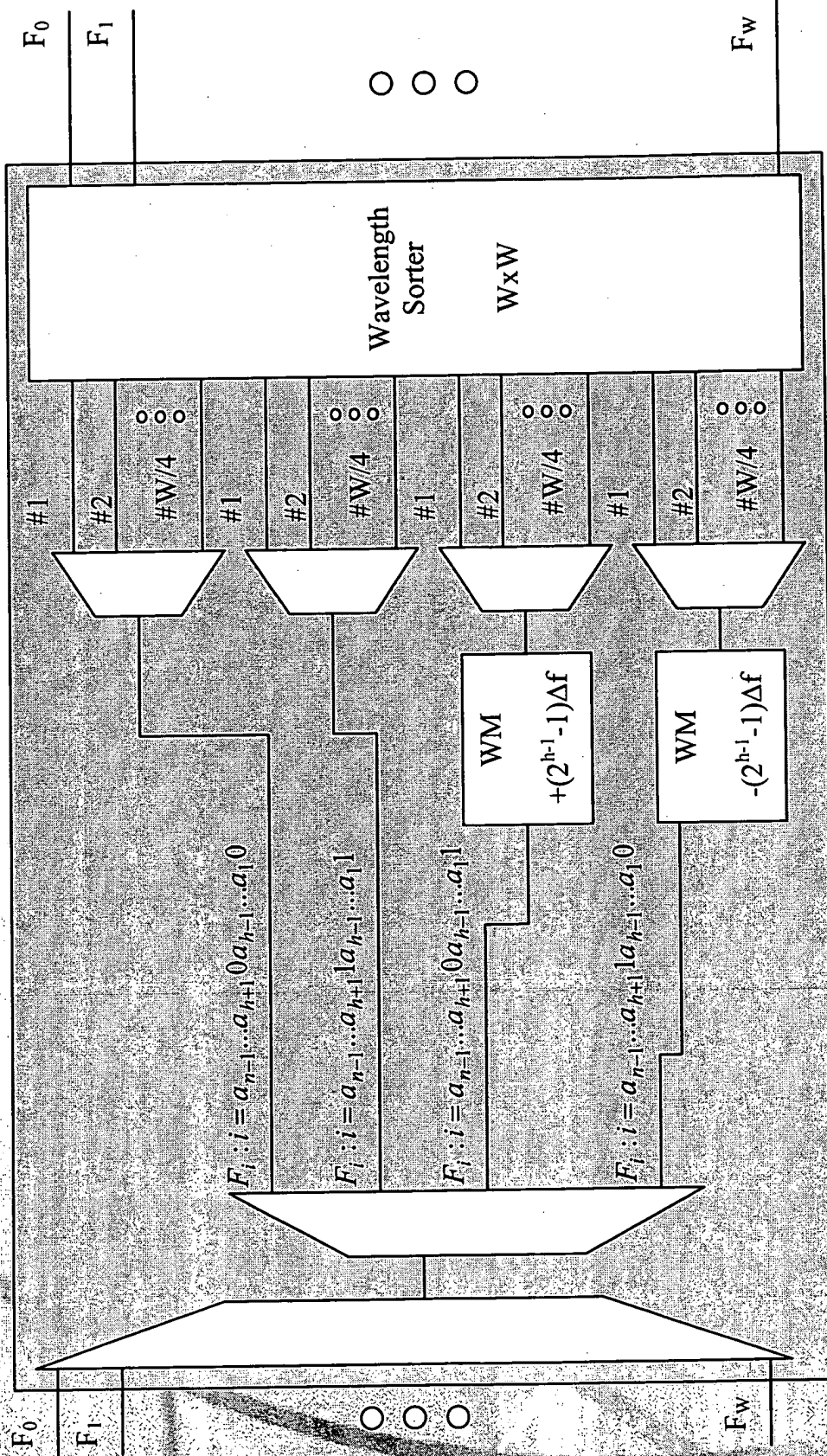
$$j(a_{n-1} \dots a_0) = a_{n-1} \dots a_0, 0 \leq h \leq n-1$$

# Banyan Switch Architectures 2/2

Networks:

	$P(0)$	$P(h), 0 < h < n$	$P(n)$
Omega	$\sigma_{n-1}$	$\sigma_{n-1}$	J
Omega <sup>-1</sup>	J	$\sigma_{n-1}^{-1}$	$\sigma_{n-1}^{-1}$
SW-banyan	J	$\beta_h$	J
SW-banyan	J	$\beta_{n-h}$	J
n-cube	$\sigma_{n-1}$	$\beta_{n-h}$	J
n-cube <sup>-1</sup>	J	$\beta_h$	$\sigma_{n-1}^{-1}$
Baseline	J	$\sigma_h^{-1}$	J

# Butterfly ISC Pattern based on Wave-Mixing

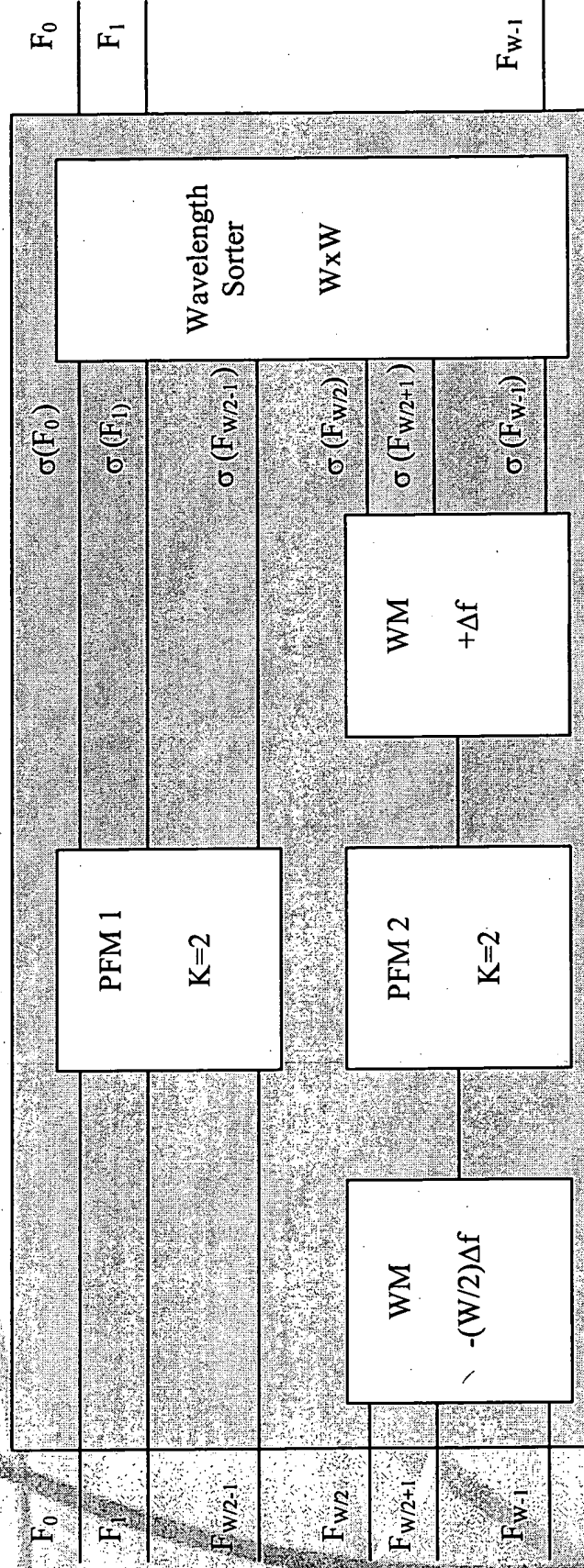


# Monotonic WC

- Wavelength-mapping operation that preserves or simply inverts the ordering relationships of wavelengths
- Devices implementing monotonic WC may be implemented with a number of wave-mixing components of the order of the logarithm of the number of wavelengths ( $O(\log(W))$ )
- Pseudo frequency multiplication
  - Mapping of  $F_i$  to  $F_{k,i}$ , for any  $i$
  - PFM is a specific example of monotonic WC

# Perfect Shuffle ISC Pattern based on PFM

- Perfect frequency shuffler using  $O(\log(W))$  wave mixing devices



# HW Requirements of Banyan Ws Designed with the New Approach

- New method

	Number of WM Devices used
Omega	$O(\log(W)^2)$
Omega <sup>-1</sup>	$O(\log(W)^2)$
SW-banyan	$O(\log(W))$
SW-banyan	$O(\log(W))$
n-cube	$O(\log(W))$
n-cube <sup>-1</sup>	$O(\log(W))$
Baseline	$O(\log(W)^2)$

- Previous approaches usually require a number of WMs of the order of  $W$

# Future Work

- Design of WIXCs with arbitrary properties in terms of the following characteristics
  - Blocking properties: rearrangeable, wide-sense non-blocking, strictly non-blocking
  - Inter-stage connection density: full/partial connection
- Impact on the transmission quality (noise, cross-talk, dispersion, ...etc), and performance requirements for WM devices to be used in the new approach
- Multicast support
- Switches with several multiplexing levels (time, wavelength and space)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT B**



**INVENTION DISCLOSURE REVIEW SUMMARY/DISPOSITION**

Initial Review Date: \_\_\_\_\_

Disclosure No.: <u>1294620</u>	Product Group: _____
Title of Disclosure: <u>Scalable wavelength-interchanges</u>	Business Unit: <u>EBTS</u>
Standards Related: <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes	<input checked="" type="checkbox"/> Nortel Inventors only
Applicable Standards: _____	<input type="checkbox"/> Nortel and Contractor Inventors
Technology Areas: <u>Optical switch fabric</u>	Product/Project: _____
Strategic Focus Area: <u>Optical networks</u>	<u>MTTP</u>

**REVIEW SUMMARY**

**GIST OF THE INVENTION**

Summarize within a few lines what the major thrust of the invention is, e.g. a software program to be added to voice networks, such as Meridian, which will allow instantaneous translations from French to English.

new architecture for interstage connection patterns

**BENEFIT FROM THE INVENTION**

Summarize within a few lines how the invention will benefit its target benefactor, e.g. subscribers will be able to retrieve multi-lingual messages instantaneously without having to employ additional time consuming translation processes which may not be readily available.

fewer active components needed

**Ranking/Scoring Data**

- a. Technological Thrust: 3 (0-3)
- b. Inventive Value: 3 (0-3)
- c. Commercial Value: 3 (0-3)

**OVERALL SCORE:** 9

**FINAL DISPOSITION**

Final Disposition Date: \_\_\_\_\_

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> File Patent Application -- Target Filing Date: _____ | <input type="checkbox"/> Close without filing                  |
| <input type="checkbox"/> Combine with/include in Disclosure No.: _____                   | <input type="checkbox"/> Reconsider/Table (see comments below) |
| <input type="checkbox"/> Other (e.g., publish, Tech. Licensing, etc.)                    |  |

Comments: \_\_\_\_\_

Critical Filing Date (If Applicable): \_\_\_\_\_

Foreign Filing Potential: ☐ No ☒ Yes

(circle) Tier 1  
(UK, DE, FR, CA)

Tier 2 : \_\_\_\_\_  
(Please specify)

(Revised: \_\_\_\_\_)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT C**

Kim LaRocca  
Outsource Administrator  
Intellectual Property Law Group  
600 Technology Park Drive, MS E65-60-403  
Billerica, Massachusetts 01821-5501  
Tel 978-288-6754 Fax 978-288-6543  
[www.nortelnetworks.com](http://www.nortelnetworks.com)



*How the world shares ideas.*

**NORTEL NETWORKS CONFIDENTIAL &  
PRIVILEGED COMMUNICATION**

August 2, 2000

CONFIDENTIAL

VIA FACSIMILE 202 778-2201, ORIGINAL NOT SENT

Thomas E. Anderson, Esq.  
Hunton & Williams  
1900 K Street, N.W.  
Washington, DC 20006-1109

Re: **Invention Docket No.: 12946RO**  
**Title: Scalable Wavelength-Interchangers Based on Frequency Comb-Shifters**  
**Required Filing Date: November 2, 2000**

Dear Attorney Anderson:

Nortel Networks would like to retain your firm to prepare and file in the United States Patent and Trademark Office (USPTO) a patent application directed to the invention disclosed in the enclosed invention disclosure by the above-referenced filing date. The application should be prepared according to Nortel Networks guidelines, and in accordance with the predetermined fee we have agreed with your firm; for the total fee of about [REDACTED] exclusive of drawing(s) and USPTO filing fees. If you are unable to perform the requested work, please advise me immediately.

In addition to the invention disclosure, an invention disclosure Review Summary document is enclosed for your consideration. We request that you contact the primary inventor, Abel Dasylyva, at (613) 763-5034 within two weeks of receiving this letter. Please ensure that the inventor(s) are advised of their responsibilities regarding their duty of candor to the USPTO, as well as any other relevant rules and/or laws including the best mode requirement.

We also ask that you quickly review the contents of this letter and its enclosures to ascertain whether or not any bar dates appear to be imminent. If so, we ask that you develop a plan of action to protect Nortel Networks' intellectual property rights in the invention disclosure.

Questions pertaining to substantive issues associated with the application should be addressed with the responsible attorney at (978) 288-6997, while administrative issues associated with the application should be addressed with me. Please be sure that all communications associated with the application, including billing statements and the application itself bear the above-referenced disclosure number.

Please send a substantially complete and final draft of the application to me along with a completed Nortel Networks Outsource's Patent Application Checklist at least 10 days prior to the above-referenced filing date to provide Nortel Networks' Intellectual Property Law Group sufficient opportunity to review the application prior to filing. You should seek to obtain the signatures on the formal papers from all inventors directly.

August 2, 2000  
Thomas E. Anderson, Esq  
Page 2

Upon filing the application with the USPTO, immediately fax a copy of the application transmittal letter and Declaration to me, so that we have a record that the application has been filed. Thereafter, please send me a hardcopy of the application as filed along with an electronic copy in Microsoft Word 6.0 readable format on a 3 1/2" floppy disk.

Please confirm receipt of this letter via facsimile. Should you have any questions, please call me at 978-288-6754.

Very truly yours,



Kim LaRocca

Enclosures:

cc: Invention Disclosure No.: 12946RO  
Review Summary

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT D**

**HUNTON &  
WILLIAMS**

1900 K STREET, N.W.  
WASHINGTON, D.C. 20006-1109

TEL 202 • 955 • 1500  
FAX 202 • 778 • 2201

THOMAS E. ANDERSON  
DIRECT DIAL: 202 • 955 • 1808  
EMAIL: andersont@hunton.com

FILE NO: 57983.000018

December 7, 2000

**VIA FACSIMILE**

Mr. Abel C. Dasyuva  
Nortel Networks  
21 Richardson Side Road  
M/S 117D1F04  
Kanata ON K2K 2C1  
Canada

Re: New U.S. Patent Application  
Title: "SCALABLE WAVELENGTH-INTERCHANGERS BASED  
ON FREQUENCY COMB-SIFTERS"  
Your Ref.: 12946RO  
Our Ref.: 57983-000018

Dear Abel:

Enclosed please find a copy of a draft of the above-identified patent application for your review. The enclosed copy is exactly the same as the one that I emailed to you earlier.

Please review this application to determine if it accurately and adequately describes your invention, noting on the enclosed draft any comments or suggestions you may have.

After you have completed your review, please return the draft to me. The patent application will then be placed in a condition for filing in the U.S. Patent and Trademark Office (USPTO), and a final version of the patent application will be sent to you for execution.

Also, pursuant to USPTO rules, a statement must be submitted disclosing to the USPTO all presently known information believed material to the examination of the above-identified patent application. Information is considered material if there is a substantial likelihood that the information would be considered important in deciding patentability. Accordingly, please send for my review all presently known patents, publications, or other published materials relating to the subject invention. Please note that you are not required to do any research to locate information that is not already known by you.

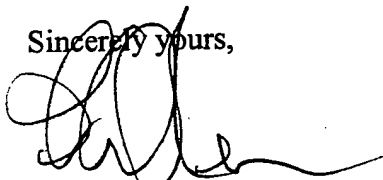
**HUNTON &  
WILLIAMS**

Mr. Abel Dasyuva  
December 8, 2000  
Page 2

Accurate and complete disclosure of material information facilitates the examination phase of the patent application, and most importantly, strengthens the presumption of validity accorded any patent issuing thereon.

If you have any questions concerning the review of the patent application or the submission of material information, please do not hesitate to contact me directly at the above-listed number.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'T. Anderson', with a long horizontal flourish extending to the right.

Thomas E. Anderson

TEA/vll  
Enclosure

cc: Holmes Anderson (via fax)

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT E**



**Anderson, Thomas**

---

**From:** Anderson, Thomas  
**Sent:** Wednesday, December 27, 2000 9:45 PM  
**To:** Abel C. Dasyva (E-mail)  
**Subject:** Your: 12946RO / Our: 57983-000018



3nnr011.doc

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT F**

**Anderson, Thomas**

---

**From:** Abel Dasyiva [abel@nortelnetworks.com]  
**Sent:** Thursday, December 28, 2000 4:06 PM  
**To:** 'Anderson, Thomas'  
**Cc:** Delfin Montuno  
**Subject:** Filing of invention 12946RO

Thomas,

Delfin and I approve of your filing our invention 12946RO.

Thanks,

-Abel

12/28/00

Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT G**



## UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS  
UNITED STATES PATENT AND TRADEMARK OFFICE  
WASHINGTON, D.C. 20231  
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
09/749,946	11/29/2000	2633	710	57983.000018	25	16	2

CONFIRMATION NO. 6810

## FILING RECEIPT



\*OC000000005756560\*

Thomas E. Anderson  
Hunton & Williams  
1900 K Street, N.W.  
Washington, DC 20006-1109

Date Mailed: 02/12/2001

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the PTO processes the reply to the Notice, the PTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).

## Applicant(s)

Abel C. Dasylya, Residence Not Provided;  
Delfin Y. Montuno, Residence Not Provided;  
Guo-Qiang Wang, Residence Not Provided;

## Continuing Data as Claimed by Applicant

## Foreign Applications

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

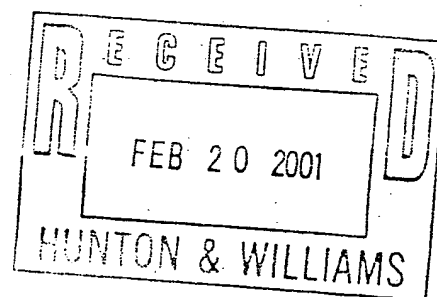
Early Publication Request: No

## Title

Technique for interchanging wavelengths in a multi-wavelength system

## Preliminary Class

359



REVIEWED  
SW

---

Data entry by : GURMU, MULUEMEBET

Team : OIPE

Date: 02/12/2001



**LICENSE FOR FOREIGN FILING UNDER**  
**Title 35, United States Code, Section 184**  
**Title 37, Code of Federal Regulations, 5.11 & 5.15**

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The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

**NOT GRANTED**

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Assistant Commissioner for Patents  
Office of Initial Patent Examination  
Customer Service Center  
Washington, DC 20231



Patent Application  
Attorney Docket No.: 57983.000018  
Client Reference No.: 12946ROUS01U

**EXHIBIT H**

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: "TECHNIQUE FOR INTERCHANGING WAVELENGTHS IN A MULTI-WAVELENGTH SYSTEM", the specification of which:

(X only one) (a) \_\_\_\_\_ is attached hereto.  
(b) X was filed as U.S. Patent Application No. 09/749,946 on December 29, 2000, and was amended on \_\_\_\_\_, 20\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby acknowledge the duty to disclose to the Office all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56, including, for a continuation-in-part application, material information which became available between the filing date of the prior application and the national or international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate, under 35 U.S.C. § 365(a) of any international application(s) designating at least one country other than the United States, or under 35 U.S.C. § 365(b) of any foreign application(s) for patent or inventor's certificate or any international application(s) designating at least one country other than the United States, listed below, and have also identified below any foreign application(s) for patent or inventor's certificate or any international application(s) having a filing date before that of any application on which priority is claimed:

Application No.	Country	Filing Date (MM/DD/YY)	Priority Claimed?
_____	_____	_____	_____

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

Application No.	Filing Date (MM/DD/YY)
_____	_____
_____	_____

I hereby claim the benefit under 35 U.S.C. § 120 of any United States non-provisional application(s) listed below:

Application No.	Filing Date (MM/DD/YY)	Status (Patented, Pending, Abandoned)
_____	_____	_____
_____	_____	_____

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.


I hereby appoint: Thomas E. Anderson, Registration No. 37,063; Stanislaus Aksman, Registration No. 28,562; Jennifer A. Albert, Registration No. 32,012; David E. Baker, Registration No. 42,285; Scott D. Balderston, Registration No. 35,436; Carl L. Benson, Registration No. 38,378; Bradford Blaise, Registration No. P47,429; Thomas M. Blasey, Registration No. 33, 475; Brian M. Buroker, Registration No. 39,125; Christopher C. Campbell, Registration No. 37,291; Robin C. Clark, Registration No. 40,956; Christopher J. Cuneo, Registration No. 42,450; Patrick A. Doody, Registration No. 35,022; Kevin T. Duncan, Registration No. 41,495; David D'Zurilla, Registration No. 36,776; Ozzie Farres, Registration No. 43,606; Nancy Flint, Registration No., 46,704; Christopher J. Forstner, Registration No. 46,049; James G. Gatto, Registration No. 32,694; George Georgellis, Registration No. 43,632; Paramita Ghosh, Registration No., 42,806; Paul D. Golian,

Registration No. 42,951; Charles F. Hollis, Registration No. 40,650; David M. Huntley, Registration No. 40,309; Nancy J. Jensen, Registration No. 45,913; Herbert V. Kerner, Registration No. 42,721; Steven P. Klocinski, Registration No. 39,251; Jonathan D. Link, Registration No. 41,548; J. Michael Martinez, Registration No. 31,178; David H. Milligan, Registration No. 42,893; James R. Miner, Registration No. 40,444; Devin S. Morgan, Registration No. 45,562; Kerry H. Owens, Registration No. 37,412; Andrew J. Ririe, Registration No. 45,597; Robert M. Schulman, Registration No. 31,196; Thomas J. Scott, Jr., Registration No. 27,836; 647Stuart I. Smith, Registration No. 42,159; Yisun Song, Registration No. 44,487; Raphael A. Valencia, Registration No. 43,216; Rene' Vazquez, Registration No. 38,647; and Scott F. Yarnell, Registration No. 45,245, all of the firm **Hunton & Williams**, 1900 K Street, NW, Washington, DC 20006, as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application, and any provisionals, continuations, continuations-in-part, divisionals, appeals, reissues, substitutions, re-examinations, and extensions thereof, and to transact all business in the United States Patent and Trademark Office connected therewith, to appoint any individuals under an associate power of attorney, and to file and prosecute any international patent application based thereon before any international authorities.

Please address all correspondence and direct all telephone calls to:

Thomas E. Anderson  
Hunton & Williams  
1900 K Street, N.W.  
Washington, D.C. 20006-1109  
telephone (202) 955-1500  
facsimile (202) 778-2201

**NAMED INVENTOR(S) :**

1	<b>Full Name</b> Abel C. Dasylva	<b>Inventor's Signature</b> 	<b>Date</b> 01/30/2001
	<b>Residence (city, state, country)</b> 1-70 Bolton Ottawa, ON Canada K1H 5A5		<b>Citizenship</b> Ivory Coast
	<b>Post Office Address (include zip code)</b> Same as residence		

2	<b>Full Name</b>	<b>Inventor's Signature</b>	<b>Date</b>
	Delfin Y. Montuno	<i>Delfin Y. Montuno</i>	Jan. 30, 2001
	<b>Residence (city, state, country)</b>		<b>Citizenship</b>
	122 Knudson Drive Kanata, ON Canada K2K 2L8		CANADA
	<b>Post Office Address (include zip code)</b>		
	Same as residence		

3	<b>Full Name</b> Guo-Qiang Wang	<b>Inventor's Signature</b> <i>G. Q. Wang</i>	<b>Date</b> <i>Jan 30, 2001</i>
	<b>Residence (city, state, country)</b> 175 Longshire Circle Nepean, ON Canada K2J4L2		<b>Citizenship</b> Canada
	<b>Post Office Address (include zip code)</b> Same as residence		

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